Contributions
of the
American Entomological Institute

Volume 13, Number 4, 1977

MEDICAL ENTOMOLOGY STUDIES - VI.

A REVISION OF THE SUBGENUS *LOPHOCERAOMYIA* OF THE GENUS *CULEX* IN THE ORIENTAL REGION (DIPTERA: CULICIDAE).

by

Sunthorn Sirivanakarn

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A REVISION OF THE SUBGENUS *LOPHOCERAOMYIA* OF THE GENUS *CULEX* IN THE ORIENTAL REGION (DIPTERA: CULICIDAE)[1].

By

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ABSTRACT

This revision is based on the study of some 8,000 specimens (3,789 males, 2,521 females, 77 pupae, 1,616 larvae). Included among these are 3,115 adults with correlated pupal and/or larval skins (1,314 p, 1,801 lp) associated through individual field rearings.

Altogether 58 species are recognized and of these, 9 are new; 49 are revalidated and redescribed. The new species include: *alorensis* from Alor, Indonesia; *paraculeatus* from Sabah, Malaysia and the Philippines; *aestivus* from Sarawak, Malaysia; *gracicornis* and *pairoji* from Peninsular Malaysia (Malaya) and Thailand; *impostor* from Sabah and Sarawak, Malaysia; *wardi* and *lasiopalpis* from Sri Lanka and *hirtipalpis* from Thailand. Keys to all available stages and illustrations of every species are provided. The taxonomic treatment includes a revised morphological characterization of the subgenus, followed by a review of distribution, taxonomic discussion, scheme of internal classification, bionomics and medical importance. The groups, subgroups and complexes, as adopted and currently developed here, are defined and characterized. The descriptions of 49 species are based on all stages (female, male, pupa and fourth instar larva) and those of 9 other species are based only on the males and presumptive female of one species.

New synonyms proposed include: *pachecoi* Baisas (= *quadripalpis* (Edwards)); *fuscosiphonis* Bram and Rattanarithikul (= *demissus* Colless); *hui* Lien (= *spiculosus* Bram and Rattanarithikul); *plantaginis* Barraud (= *minor* (Leicester)) and *uniformis mercedesae* Baisas (= *kuhnsi* King and Hoogstraal). *Culex bicornutus* (Theobald) is resurrected from the synonymy with *minor* (Leicester); *barkerii* (Theobald), *bernardi* (Borel) and *mindanaoensis* Baisas are reduced to nomina dubia.

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[1]This work was supported by Research Contract No. DAMD-17-74-C-4086 from the U. S. Army Medical Research and Development Command, Office of the Surgeon General, Washington, D. C.

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INTRODUCTION

The genus *Culex*, subgenus *Lophoceraomyia* is an Old World taxon with characteristic distribution confined to the Oriental, eastern Palearctic and Australasian regions and the islands of the western and south Pacific Ocean. Of all the subgenera of *Culex* in the Oriental region, *Lophoceraomyia* is apparently the richest in number of species. The majority of these occur in Southeast Asia and neighboring areas where they form one of the common elements of the culicids of tropical rain forests. After the recognition of the group by Theobald (1905a, 1905b), the subgenus has been the subject of several taxonomic studies, but most of these are strictly local, or limited to the descriptions of species and additional descriptions or records of previously known species. A number of regional studies prior to 1960, in which the group was treated as a unit include Leicester (1908), Borel (1926, 1930), Barraud (1934), Baisas (1935), Bohart and Ingram (1946) and LaCasse and Yamaguti (1950). Since the discovery of arbovirus infections in wild-caught adults by the U. S. Army Medical Research Unit in Peninsular Malaysia (Anonymous 1960), further significant intensive studies of local species have been made. These include an excellent review by Colless (1965) in Malaya, followed by the studies of Delfinado (1966) and Baisas (1974) in the Philippines, Bram and Rattanarithikul (1967) and Bram (1967a) in Thailand. Other works dealing only with descriptions of new species during this later period are Wang and Feng (1964) in Yunnan, southern China; Rahman, Choudhury and Kalra 1968 (1969) in India and Lien (1968) in Taiwan.

During the past 10 years since the Southeast Asia Mosquito Project (SEAMP, 1964-1974, currently replaced by the Medical Entomology Project (MEP)) was initiated, a considerable amount of *Lophoceraomyia* material from various parts of the Oriental region has accumulated and more information on distribution, bionomics and medical importance of many species has been obtained. This material, which represents the largest collection from the area, consists of numerous reared specimens of nearly all previously known species and a number of undescribed species. A long term study of this material together with my subsequent study of the various types and topotypic specimens of species from India, Sri Lanka and other countries at the British Museum (Natural History) and the U. S. National Museum now make it possible to attempt a broad regional revision of the subgenus.

The present revision includes almost all species previously described from the Oriental region. A total of 58 species are treated. Of these, 49 of the previously recognized species are redescribed and 9 are considered as new. Approximately 8,000 specimens [3,789 males, 2,521 females, 77 pupae, 1,616 larvae; 1,314 p, 1,801 lp] have been examined. Forty-nine species are known and described in all stages and 9 other species are described only from the males, including one also with presumptive female.

MATERIAL AND METHODS

The largest portion of the material for this study came from the extensive collections made since 1964 by the Department of Medical Entomology, U. S. Army Medical Component--SEATO, Bangkok, Thailand; the Malaysia Mosquito Project, Department of Parasitology, University of Malaya and by several

individuals from U. S. Army Medical units, local governmental agencies and private institutions in the Philippines, Malaysia, Vietnam, Indonesia and the Ryukyus, Japan. Numerous additional fresh adult specimens, both field-caught and reared have been obtained from the recent collections in Sri Lanka by the Smithsonian Institution's "Biosystematic Studies of the Insects of Ceylon" project, in Indonesia by S. Ramalingam, University of Malaya, T. Kurihara, Teikyo University and Yoshito Wada, Nagasaki University, Japan, in the Andaman Islands and Madras, India by N. L. Kalra and B. N. Mohan. The remaining specimens examined were largely field-caught adults, representing the type or parts of the original type-series and topotypic specimens, from loans made to the project by the British Museum (Natural History); Division of Entomology, CSIRO, Australia; Bishop Museum, Honolulu; Institut Voor Tropische Hygiene, Amsterdam, the Netherlands; Field Museum of Natural History; California Academy of Sciences; Academy of Natural Sciences (Philadelphia) and the collection of the U. S. National Museum.

Vital to this study were the collections of the British Museum (Natural History) and U. S. National Museum. The collection of the British Museum was most important because of its broad representation of species and accumulation of the types (holotypes, lectotypes) and other specimens in the original type-series. The collection of the U. S. National Museum has become increasingly important in recent years. This collection contains all holotypes and most of the specimens in the type-series of the species described by Bohart (1946), Stone and Bohart (1944), Delfinado (1966) and Bram and Rattanarithikul (1967) and several paratypes deposited by Colless (1965) and Lien (1968). Included also are a few types and some topotypic specimens of the species described by Ludlow (1909), Dyar (1920) and Baisas (1935) from the Philippines.

Among the recent collections which significantly contributed to a better knowledge (biological, taxonomic, distributional) of several previously known species, 4 deserve special mention here. The excellent collection of the Malaysia Mosquito Project directed by Shivaji Ramalingam is well balanced, containing many reared specimens with adequate associated pupal and larval skins of most Malaysian species and the material collected and prepared is of high research quality. The collections throughout Thailand of the SEATO Laboratory directed by John E. Scanlon (1960-64) and Douglas J. Gould (1964-76) and the earlier collections by D. C. and E. B. Thurman (1952-57) are the largest of all, containing numerous field-caught (by light traps or nets) and reared specimens of most local species. The private collection of the late F. E. Baisas in the Philippines, which was donated to the U. S. National Museum in 1968, has a good series of reared specimens of locally common species but most of these were from Subic Naval Base in Luzon. Finally, the most recent collection by E. L. Peyton and Y.-M. Huang in Sri Lanka of the Smithsonian Biosystematic Studies of the Insects of Ceylon, is perhaps the most comprehensive collection ever made in that country. This collection has numerous reared specimens of nearly all known local species, additional new records of the species known elsewhere and some undescribed species.

The format of presentation and descriptions of species in general follows the preceding *Culex* papers by Bram (1967a) and Sirivanakarn (1972) and subsequent papers by the latter author. The terminology of important taxonomic characters used throughout were those of Sirivanakarn (1968), which were modified from Belkin (1962) and Colless (1965). The only changes which have been made here are certain features of the male genitalia. To simplify the description of the specialized setae and leaflets of the subapical lobe, the alphabetical designations such as *a*, *b*, *c*, etc., as used by Belkin (1962) are

adopted. In describing the lateral aedeagal plate of the phallosome of the species in the *Mammilifer* Group, I have introduced the term "external process" to substitute the "dorsal process" used by Colless (1965), simply to distinguish it from the other process, the internal process of the same author.

TAXONOMIC TREATMENT

SUBGENUS *LOPHOCERAOMYIA* THEOBALD

Lophoceraomyia Theobald 1905a: 245. Type-species: *L. uniformis* Theobald 1905a, Ceylon (Sri Lanka); monobasic. Considered as a lapsus for *Lophoceratomyia* by some authors.

Lophoceratomyia Theobald 1905b: 93. Type-species: *L. fraudatrix* Theobald 1905b, New Guinea; the first of 2 included species, selection of Brunetti (1914: 64). Considered as a lapsus for *Lophoceraomyia* by some authors, as a valid emendation by others.

Philodendromyia Theobald 1907: 623. Type-species: *P. barkerii* Theobald 1907, Sarawak (Malaysia); monobasic.

Cyathomyia de Meijere 1910: 921. Type-species: *C. jenseni* de Meijere 1910, Java (Indonesia); monobasic.

Culex (Lophoceraomyia) Theobald, Bohart and Ingram (1946: 1-110); King and Hoogstraal (1955: 1-11); Bohart (1956 (1957): 66-70); Dobrotworsky (1957 (1958): 317-21); Stone, Knight and Starcke (1959: 232-5); Stone (1961: 45); Belkin (1962: 248-72); Stone (1963: 133-4); Assem and Bonne-Wepster (1964: 111-3); Colless (1965: 261-307); Delfinado (1966: 101-15); Stone (1967: 213-5); Bram (1967a: 42-113); Sirivanakarn (1968: 75-186); Baisas (1974: 111-22).

Culex (Lophoceratomyia) Theobald, Leicester (1908: 18-261); Edwards (1924: 396-7); Borel (1930: 352-64); Edwards (1932: 196-8); Barraud (1934: 359-76); Baisas (1935: 167-79); Feng (1938: 296-9); Carter and Wijesundara (1948: 144); LaCasse and Yamaguti (1950: 192-201); Bonne-Wepster (1954: 111-3); Wang and Feng (1964: 37-41).

FEMALE. Small to medium sized (wing length 2.0-3.5 mm), usually blackish, sometimes yellowish, reddish or tan-brown; palpus, proboscis and legs without any pale markings. *Head.* Decumbent scales on dorsum of vertex varying from narrow, linear to broad clavate or ovate, color varying from pale whitish or yellowish, forming a distinct ocular line to predominantly dark, brownish or blackish; erect scales numerous, usually entirely dark brown or black, sometimes largely pale, yellow or golden; lateral patch of broad scales at side of eye usually pale beige or bluish white, sometimes entirely dark; frontal tuft of scales poorly developed or absent; frontal and dorsolateral ocular bristles very strong, usually dark, sometimes golden brown; subocular bristles weak, dark or slightly pale. Palpus entirely dark scaled, 4-segmented, 0.20-0.25 of proboscis length; segment 4 longest, as long as or longer than combined length of segments 1-3. Proboscis entirely dark scaled, slightly longer than forefemur; labial basal setae weak, hairlike, usually 2-4 in number, sometimes 6. Antenna as long as proboscis; pedicel with or without minute patch of tiny setae or scales on inner dorsal surface; flagellum composed of 13 subequal flagellomeres; flagellomere 1 with several short setae in middle; flagellomeres 2-13 with numerous short setae and each with a basal whorl of 5-8 bristles, the latter 1.5-2.0 times as long as length of individual

flagellomere. *Cibarial Armature:* Well developed; cibarial bar with 15-60 distinct teeth in concave row; length and thickness of teeth variable; cibarial dome oval or hemispherical, with numerous minute tubercles or denticles. *Thorax*. Mesonotal integument usually dark brown, sometimes yellowish, reddish brown or almost black; mesonotal scales narrow, curved, sparse or moderately dense, entirely dark brown or black; acrostichal bristles usually absent except on extreme anterior promontory, sometimes present, weakly developed, extending to anterior 0.5 of disc; dorsocentral, supraalar and scutellar bristles well developed, very strong, dark brown or black. Pronotal integument same color as mesonotum; anterior pronotum (*apn*) with short setae and bristles only; posterior pronotum (*ppn*) entirely bare or with scattered short and weak setae and narrow scales on anterior surface cephalad of 4-6 posterior bristles. Pleuron slightly paler or concolorous with mesonotum, usually without distinct scale patches on propleuron *(ppl)*, sternopleuron *(stp)* and mesepimeron *(mep)*, sometimes with a few to many pale scales restricted to upper corner and posterior border of *stp* and upper *mep;* 1 lower *mep* bristle usually present, sometimes absent. *Legs*. Forecoxa with dark scale patch and several strong, curved setae on anterior surface; midcoxa with a vertical row of 4-6 dark bristles and a small pale scale patch on antero-lateral surfaces; hindcoxa with lateral pale scale patch and a posterior row of setae; anterior surface of forefemur and midfemur dark brown or black, ventral surface pale; anterior surface of hindfemur usually with longitudinal white stripe extending from base to near apex, sometimes absent or entirely dark; tibiae and tarsi of all legs dark brown or bluish black; all claws small, equal and simple; pulvilli well developed. *Wing*. Scales on all veins dark brown or black; scales on C, Sc, R and R_1 dense and broad; plume scales on R_2, R_3 moderately dense, narrow, linear or broad clavate; fringe scales on wing margin dusky; cell R_2 1.5-2.0 times as long as its stem (R_{2+3}); alula with a few short marginal setae; upper and lower calypter fringed with several long, hairlike setae. *Halter*. Peduncle pale and bare; capitellum covered with dark scales. *Abdomen*. All terga usually dark brown or black, sometimes with basolateral pale spots or complete basal pale bands; sterna usually pale beige yellowish, sometimes largely dark. *Genitalia*. Very similar in all species. Segment VIII partially retracted into segment VII; sternum VIII with several bristles in middle of posterior caudal margin; median caudal margin lightly or moderately emarginate. Segment IX largely retracted into segment VIII; tergum IX narrow, ribbonlike, with a lateral row of 3-4 weak setae on each side. Cercus thumblike, short or moderately long, with several setae and numerous spicules. Postgenital plate broad, oblong, not projecting beyond apex of cercus; caudal margin broadly rounded or lightly emarginate at middle; apical 0.5 with 4, 5 setae in 2 parallel rows, rest of plate largely spiculose. Posterior cowl very narrow, entirely spiculose. Sigma largely membranous and densely spiculose. Insula with a tuft of 8 strong setae. Vaginal sclerite in form of an inverted U, weakly sclerotized, lightly to moderately pigmented.

MALE. In general similar to female, differing in smaller size and scantier scales on the wing veins. *Palpus*. Long, slender, 5-segmented, usually exceeding proboscis by 0.5-1.0 of the length of segment 5, sometimes reduced to 0.5 of proboscis length; segment 1 with or without 2 pairs of small, short finger-like processes on lateral and ventral surfaces; segment 3 with 1, 2 ventral rows of short, tiny setae, sometimes with numerous fine setae forming dense rows, apical 0.25 with a weak ventrolateral tuft of dark bristles, number of bristles varied; segments 4 and 5 weakly to strongly plumose, usually subequal, seg-

ment 5 sometimes considerably reduced in length. *Proboscis*. Slender or moderately thick; false joint present at 0.25 from base or absent; dorsal surface of labium with or without a double row of upright, sinuous setae extending from 0.25 of length to almost apex; lateral and ventral surfaces usually with a few rows of short setae, widely spaced along whole length, sometimes with a few long hairs or a dense group of several setae in middle; labial basal setae short, hairlike or spinelike, 10-12 in number, in transverse row. *Antenna*. Pedicel smooth, rounded, with or without distinct nipplelike spiculose prominence (or mammiliform process) on inner dorsal surface; flagellum moderately to densely long plumose; flagellomeres 1-11 subequal, 12, 13 elongate; flagellomeres 5-10 or 5-9 with modified tufts of scales and setae, sometimes modified tufts restricted to flagellomeres 7 and 8, rarely absent entirely; minor whorl of short setae distad of normal whorls absent or not developed on flagellomeres 2-11. *Thorax*. Setae on *ppl* usually more numerous than in female. *Legs*. Claws of fore- and midlegs enlarged, with basal denticles; claws of hindleg small and simple, as in females.

MALE GENITALIA. *Segment IX*. Tergum narrow, lateral tergal lobe small, poorly developed, with 3-5 weak or moderately strong setae; sternum broad, more or less rectangular, usually with one or more transverse rows of strong setae and scales towards caudal margin, sometimes absent. *Basimere*. Small slender, roughly conical, with convex lateral tergal margin and concave tergomesal margin, sometimes modified; scales absent; strong bristles confined to lateral tergal surface; inner tergal surface usually with a few to several strongly differentiated submarginal setae, in row or patch from near base to level of subapical lobe, sometimes absent or with short and weak setae only; tergomesal margin with one or a few rows of marginal setae. *Subapical Lobe*. Prominent, usually not clearly divided into proximal and distal divisions, setae on lobe densely packed, usually well differentiated; proximal part usually with 3 stout, subequal rods *(a-c)*; distal part usually with a mesal group of 1 club-shaped leaflet (g_2) and 4-6 flattened bladelike, narrow rodlike or fine hairlike setae *(d-f)* and a lateral group of 1 leaflet (g_1) and 1 strong basal seta *(h)*. *Distimere*. Slender, curved in middle, distal portion usually tapered into a blunt recurved apex, latter sometimes enlarged or modified; subapical dorsal surface usually without a crest of spicules; dorsal and ventral tiny setae present, usually placed subapically, sometimes near middle of curvature; subapical claw (or spiniform) slender, short, small and simple. *Phallosome*. Aedeagus relatively simple, composed of 2 lateral plates which are connected by a broad basal and a narrow submedian tergal bridge; apical portion of lateral plate [or dorsal lobe (DL)] simple, beaklike, with apex projecting tergad or composed of a stout, denticulate or tuberculate external process (EP) and a slender simple spinelike internal process (IP), sometimes represented by a broad, heavily denticulate external process only; basal 0.5 of lateral plate represented by a simple, rounded ventral (or sternal) lobe (VL) which is more or less prominent in lateral aspect, sometimes reduced or indistinct; paramere and parameral apodeme well developed, very similar in all species. *Proctiger*. Apical crown of spicules small to large; number and texture of spicules varied, paraproct narrow, well sclerotized, its apex usually with distinct lateral and sternal lobes, placed adjacent to apical crown; basal sternal process absent; basolateral sclerotization poorly or well developed, apparently attached to base of paraproct; cercal sclerite poorly sclerotized; cercal setae 2-4 in number.

PUPA. Pigmentation of cephalothorax and abdomen varying from uniformly pale, creamy or yellowish white to tan brown. *Trumpet*. Yellowish to dark

brown; usually very slender, long, more or less cylindrical (length 0.5-0.8 mm; index 10-16), sometimes short, stubby, bell-shaped or funnel-shaped (length 0.2-0.3 mm; index 3-4); pinna same diameter as meatus or slightly flared towards apex, with or without slit extending to meatus. All setae developed, relative position of setae essentially similar to other *Culex* subgenera. *Metanotum*. Seta 10-C usually double, sometimes single, rarely triple or more branched; 11-C subequal to 10-C, single or double. *Abdomen*. Seta 1-II usually brushlike or strongly dendritic, with several distal branches, sometimes forked into 3-5 branches; setae 5-IV-VI strong, 1-2 times as long as segment following; 5-IV 1-7 branched; 5-V 1-5 branched; 5-VI single or double rarely triple; 9-VIII well removed from caudolateral angle. *Paddle*. Usually oval shaped; sometimes hemispherical; usually pale whitish to almost transparent; margin of outer part distinct, smooth or lightly spiculated in basal 0.50-0.75, apical 0.25-0.50 rather indistinct; setae 1,2-P usually present, minute.

LARVA. Generally similar to other *Culex* subgenera. *Head*. Usually broader than long; ocular bulge usually prominent; collar dark; labrum well developed; seta 1-C usually dark, spiniform, with or without accessory lateral spicules or spines, sometimes pale, blunt-tipped or tapered into a fine point; 2-C absent; 14-C usually double, sometimes single or more branched; 16, 17-C usually present, sometimes absent. Antenna shorter than or nearly as long as head; basal 0.5 of shaft usually with numerous strong spicules, sometimes absent or poorly developed; seta 1-A usually large, fan-shaped, multiple, sometimes strongly reduced, 3,4 branched; 2,3-A usually long, bristlelike, situated subapically, sometimes very weak, situated apically. Mouth brush filamentous, sometimes more or less flattened. Mental plate with 6-8 strong lateral teeth on each size of median tooth. *Thorax*. Spiculation usually lightly to moderately developed or completely absent, sometimes strongly developed and extremely dense, setae 1,2-P strong, long, subequal and single; 3-P reduced to 0.25-0.50 of length of 1,2-P, usually single or double, sometimes more branched; 4-P strong, subequal to or slightly shorter than 1,2-P, 1-4 branched; 7-P strong, 1-3 branched; 8-P usually subequal to 7-P, sometimes greatly reduced, 1-3 branched; 14-P single or double. Seta 1-M shorter or as long as 3-M, single. *Abdomen*. Spiculation as in thorax; seta 7-I usually double, sometimes single or 3-5 branched. Comb scales usually numerous forming a broad oval or triangular patch. Saddle complete, concolorous with siphon, caudolateral margin lightly to strongly spiculate, sometimes practically smooth or with fringe of numerous spines; setae 4-X (ventral brush) usually with 6 pairs of branched setae (total 12), sometimes 5, all inserted within grid; anal gills as long as or longer than saddle. *Siphon*. Usually very long, slender or very thin, distally tapering, 4-6 times as long as saddle, sometimes reduced to 0.5-2.0 of saddle length; pigmentation varied from pale yellow to dark brown; pecten well developed; siphonal tufts weak, widely spaced or strong, closely spaced, 3-8 pairs (total 6-16), all of which are situated subventrally distad of pecten; median caudal filament of spiracular apparatus present or absent.

SYSTEMATICS. The subgenus *Lophoceraomyia* is characterized in the male by the presence of modified scales and setae forming conspicuous tufts at the bases of the flagellar whorls of the antenna. These peculiar tufts are developed on at least flagellomeres 7-8 or in the vast majority of species on flagellomeres 5-10 or 5-9. Currently, 2 members of the subgenus are known including: *impostor* n. sp from Sabah, Malaysia and *sumatranus* Brug 1931 from Sumatra, Indonesia, in which these characters are absent. Another

unusual feature of *Lophoceraomyia* is the presence of acrostichal bristles on the mesonotal disc in certain species: *pairoji* n. sp. from Thailand and *kusaiensis* Bohart [1956 (1957)] from Micronesia. Accordingly, I have given above a more detailed description of the subgenus than in the past by including the multitude of characters of the adults and the immatures.

All stages of *Lophoceraomyia* can be readily recognized and distinguished from other subgenera of *Culex* in the Oriental region (including *Acalleomyia*, *Culiciomyia*, *Eumelanomyia*, *Culex*, *Lutzia* and *Barraudius*) by the following combination of characters: *adults* of both sexes by (1) relatively small size (wing length not exceeding 3. 5 mm); (2) general coloration usually blackish or dark brownish, without pale markings on palpus, proboscis and legs; (3) scales on mesonotum entirely dark, moderately dense or sparse, producing a rough appearance; (4) acrostichal bristles absent on mesonotal disc (except *pairoji*); (5) pleural scale patch largely absent (except *sumatranus* and *curtipalpis*); (6) 1 lower *mep* bristle usually present; (7) wing scales moderately dense or sparse and (8) abdominal terga usually completely dark, or sometimes with basolateral pale spots or basal transverse pale bands; *male* by (1) antennal pedicel sometimes with spiculose prominence on dorsal inner surface; (2) antennal flagellomeres 5-10, 5-9 or 7-8 with modified tufts of scales and setae (except *impostor* and *sumatranus*); (3) minor whorls of short setae distad of normal large whorls of long setae on flagellomeres 2-11 absent; (4) palpus very slender, usually as long as or longer than proboscis, sometimes reduced to 0. 5 of proboscis; (5) palpal segment 1 sometimes with small, fingerlike processes and (6) proboscis sometimes with false joint at 0. 25 from base; *male genitalia* by (1) basimere without any scales; (2) distimere usually without distinct crest of spicules on dorsal subapical surface; (3) lateral plate of phallosome relatively simple, sometimes with small distinct denticles or tubercles and (4) basal sternal process of proctiger absent; *pupa* by (1) trumpet usually long, slender and cylindrical (except in certain pitcher plant species); (2) seta 10-C single or double, or not exceeding 3 branches and (3) seta 9-VIII well removed from caudolateral angle; *larva* by (1) setae 16, 17-C usually present; (2) seta 14-C usually bifid; (3) seta 3-P short, 0. 25-0. 5 of 1, 2-P; (4) seta 4-P strong, slightly shorter or subequal to 1, 2-P; (5) 7-P double or triple; (6) 8-P usually subequal to 7-P, sometimes strongly reduced, single or double; (7) 14-P single or double; (8) siphon very slender and long (except for certain pitcher plant species); (9) all siphonal tufts inserted subventrally and (10) ventral brush of saddle (or 4-X) with 6 pairs of branched setae.

Practically all *Lophoceraomyia* species have been recognized on the basis of the differences in the male antenna, palpus, proboscis and genitalia. The females of most species are difficult to identify except by correlation with the males through associated larval and/or pupal skins from individual field rearings. The female cibarial armature may be significant as a specific or group character but the female genitalia are of little or no taxonomic value. The larvae and pupae which have been studied so far also provide several important taxonomic characters for separating as well as grouping species at various levels. They are, in several cases, of equal significance to the male characters.

Prior to this study, approximately 55 *Lophoceraomyia* species were considered as valid taxa for the Oriental region (Stone, Knight and Starcke 1959; Stone 1967; 1970). In this study, nearly all nominal species previously described by Borel (1930), Barraud (1934), Baisas (1935; 1974), Colless (1965, 1967), Delfinado (1966), Bram and Rattanarithikul (1967), Bram (1967a) and other authors are treated. The only nominal forms not included here are:

bernardi (Borel 1926) from Vietnam, *mindanaoensis* Baisas 1935 from the Philippines, *szemaonensis* Wang and Feng 1964 and *harpagophallus* Wang and Feng 1964 from Yunnan, China and *raghavanii* Rahman, Choudhury and Kalra 1969 from India. The types of *bernardi* and *mindanaoensis* are apparently lost and none of the topotypic material has been found to agree with the published descriptions. It is possible that they were erroneously described and both are perhaps better reduced to nomina dubia for the present. The types and topotypic specimens of *szemaonensis*, *harpagophallus* and *raghavanii* were not available for this study, but from the descriptions and the figures of the male antennae and genitalia by their authors, it appears probable that *szemaonensis* may be conspecific with *ganapathi* Colless 1965, *harpagophallus* with *minor* (Leicester 1908) or *bicornutus* (Theobald 1910) and *raghavanii* with *flavicornis* Barraud 1924.

In this study, 58 species of *Lophoceraomyia* are recognized from the Oriental region. Of these, 49 are revalidated and 9 are considered as new. In treating the previous nominal species, the following taxonomic changes have been made: (1) synonymizing *pachecoi* Baisas 1935 with *quadripalpis* (Edwards 1914a); (2) resurrecting *bicornutus* (Theobald 1910) from the synonymy with *minor* Leicester 1908 proposed by Bram (1967a); (3) synonymizing *hui* Lien 1968 with *spiculosus* Bram and Rattanarithikul 1967; (4) synonymizing *fuscosiphonis* Bram and Rattanarithikul 1967 with *demissus* Colless 1965; (5) synonymizing *plantaginis* Barraud 1924 with *minor* (Leicester 1908); and (6) relegating *barkerii* (Theobald 1907), *bernardi* (Borel 1926) and *mindanaoensis* Baisas 1935 to nomina dubia. The new species recognized are: *alorensis* from Alor, Indonesia; *paraculeatus* from Sabah, Malaysia and the Philippines; *aestivus* from Sabah, Malaysia; *gracicornis* from Peninsular Malaysia (Malaya); *pairoji* from Thailand; *impostor* from North Borneo, Malaysia; *wardi* and *lasiopalpis* from Sri Lanka and *hirtipalpis* from northern Thailand.

CLASSIFICATION. The classification of the Oriental *Lophoceraomyia* adopted here is modified from Edwards (1932; in Barraud 1934) and Colless (1965). The 58 species treated here apparently fall into 3 natural groups: *Fraudatrix*, *Mammilifer* and *Wilfredi* on the basis of the male phallosome, antennal pedicel, palpus and proboscis as indicated in the key to groups. Of these, 23 species belong to the *Fraudatrix* Group, 32 to the *Mammilifer* Group and 3 to *Wilfredi* Group. The *Fraudatrix* Group is subdivided into 2 subgroups: *Minutissimus* and *Fraudatrix*. The latter is further split into 7 complexes: *seniori*, *cinctellus*, *rubithoracis*, *inculus*, *quadripalpis*, *variatus* and *alphus*. The *Mammilifer* Group is divided into 2 subgroups: *Mammilifer* and *Brevipalpus* (or subgroups B_1 and B_2 of Colless 1965). The *mammilifer* Subgroup includes all species previously treated by Colless (loc. cit.) except *wilfredi*. It is split into 8 complexes: *impostor*, *traubi*, *mammilifer*, *ganapathi*, *minor*, *peytoni*, *pholeter* and *flavicornis*. The *Brevipalpus* Subgroup is divided into 5 complexes: *navalis*, *hewitti*, *jenseni*, *brevipalpus* and *curtipalpis*. For more detailed discussions on the characterization and the alignment of species according to this scheme, see the treatment of the groups and subgroups.

AFFINITIES. Among the subgenera of *Culex*, *Lophoceraomyia* apparently exhibits the strongest affinity with *Eumelanomyia* as pointed out by Sirivanakarn (1971, 1972). This relationship is evident in the following features: (1) adults - scales on mesonotum dark, narrow, sparse or moderately dense; pleuron without distinct scale patches; female cibarial armature with numerous teeth; male proboscis without median tufts of long hairs on ventral surface; (2) male genitalia - development of setae and leaflets of the subapical lobe; distimere without crest of strong spicules on subapical dorsal surface; shape and relatively simple structure of phallosome; absence of basal sternal process

of the proctiger; (3) pupae - long, slender trumpet; seta 10-C single or double, rarely more branched; (4) larvae - stout, spiniform seta 1-C, presence of setae 16, 17-C; seta 3-P weaker and shorter than 1, 2-P; seta 14-P single or double; siphon slender and relatively long (except for certain pitcher plant species); ventral brush (4-X) of saddle with 6 pairs of branched setae.

Based on the similarity in the adults and male genitalic characters, *Lophoceraomyia* is apparently closest to the *rubinotus-rima* group of *Eumelanomyia* and it seems plausible, as suggested earlier (Sirivanakarn 1971, 1972) that it was probably a derivative of that group in the latter subgenus. On a broad comparative basis, *Lophoceraomyia* also exhibits some similarity to *Culiciomyia* in the simple male phallosome and general external features of the adults but differs from all known members of the latter subgenus very strikingly in several other features of the male, male genitalia and immature stages. The affinity between *Lophoceraomyia* and *Culiciomyia* as suggested by Colless (1965) does not seem to be tenable on the basis of present knowledge.

EVOLUTION. Only a broad generalization on the evolution of *Lophoceraomyia* is discussed here. Although this topic has been discussed in general by Colless (1965: 265), my knowledge of the group in the Papuan subregion (Sirivanakarn 1968) together with the current study of the Oriental fauna and others has warranted further speculation on the phylogeny and other aspects of the evolution in the subgenus. We still lack knowledge of the subgenus in some critical areas, especially among the islands of Indonesia, including Borneo and other islands to the west of New Guinea and it is quite conceivable that further study of these areas would fill numerous gaps in providing more concrete evidence concerning the place of origin and the phylogeny of some major group taxa.

On the basis of morphology, breeding habitats and zoogeography, it appears most probable as suggested by Colless (1965) that the most primitive forms of *Lophoceraomyia* are representatives of the *Mammilifer* Group (or Group B) rather than the more widespread *Fraudatrix* Group (or Group A). These primitive forms probably originated in the Indomalayan area or Southeast Asia where the subgenus *Eumelanomyia* is predominant. The males of these forms may have been primitively *Eumelanomyia*-like in the absence of special modifications of the antennal pedicel and flagellum, as exhibited by some *Lophoceraomyia* species, such as *impostor* from Sabah, North Borneo, *sumatranus* Brug from Sumatra; *bolii* Sirivanakarn and *digoelensis* Brug from New Guinea (Sirivanakarn 1968: 100-5). These presumptive *Eumelanomyia*-like forms were probably ground pool breeders and were presumably widely scattered among the areas between Borneo and the Moluccas and subsequently gave rise to various phyletic lines of the *Mammilifer* Group, which were further differentiated into several forms through specialization in breeding habitats and geographic isolation. Concurrently or subsequently some of these primitive *Mammilifer* forms gave rise to the members of the *Fraudatrix* group which were widely dispersed northwest into Asia and east and southeast into New Guinea, northern Australia, islands of the Central and Western Pacific (Micronesia) and the South Pacific. As opposed to the view of Colless that New Guinea may be the ancestral home of the *Fraudatrix* Group, I however believe that the several islands of Indonesia to the west of Wallace's and Weber's lines are the more likely places where the ancestors of this group originated and subsequently radiated in all directions. The distribution patterns as shown by the contemporaneous faunas appear to correspond to Dispersal 5 of Belkin (1962) and the origin and the course of evolution of the group probably took place during the Tertiary period (75 million years ago) according to the view tentatively advanced by Colless

(1965).

As can be discerned, the most important factors in determining the course of speciation of *Lophoceraomyia* are primarily the types of breeding habitat and geographic isolation. In addition, other factors such as population size, flight range and adult behavior are also important in stabilizing population structure as well as in preventing newly adapted forms from cross breeding. These intrinsic factors together with the types of breeding habitats apparently play a major role in the proliferation of the numerous species in the *Mammilifer* Group. Because of the restriction in breeding sites, such as bamboos, tree holes, pitcher plants and other natural containers associated with the types of tropical forest formation, the majority of the species in this group are largely endemic or indigeneous and are not susceptible to introduction into a new zone through geographic isolation and dispersal agencies. This may explain why the group is almost exclusively Indomalayan. The occurrence of several closely related forms within this area strongly indicates that the evolution in the *Mammilifer* Group largely took place through sympatric speciation. The same generality can be accounted for the *Fraudatrix* Group. However, as it is composed largely of breeders in ground pools, there is obviously a tendency for these forms to be capable of invading a new zone and become widely established through geographic isolation and various dispersal mechanisms.

BIONOMICS. The majority of *Lophoceraomyia* species are restricted to humid tropical forests and only a few members occur in open cultivated lands such as rice fields and plantations. In the Oriental region, they are found breeding in a variety of habitats, ranging from general ground pools (most species in the *Fraudatrix* Group) to rock holes, tree holes, bamboo stumps, leaf axils of pandanus and pitcher plants (most species in the *Mammilifer* Group). Elsewhere, in the South Pacific (Belkin 1962), some members of the *Fraudatrix* Group were also reported from leaf axils of aroids and pandanus and artificial containers. In the Papuan subregion (Sirivanakarn 1968),they have also been found breeding in palm bracts, sago stumps and sago leaf axils. The adults of most species have been obtained from rearing the larvae or pupae. By sweeping with nets, several were also caught while they were flying or resting on leaves of plant seedlings or shrubs. They were also caught in Malaise traps and occasionally in light traps. In Malaya, Reid (1941) reported that an unknown *Lophoceraomyia* species was observed to feed on the tree snake *(Passerita prasina)* and Colless (1965) noted that a number of species are known to attack man under forest cover but are rarely taken with mammalian baits in the open. In a study using the precipitin test (Colless 1959), the females were normally found to obtain blood meals from wild birds. *Lophoceraomyia* were reported to feed on frogs and occasionally on man in Australia (Marks 1960). In Japan, females of *C. infantulus* were reported to feed readily on frogs, snakes, lizards, turtles, chicks and mice in the laboratory (Miyagi 1972, 1973). In New Guinea, several wild-caught females were found to be engorged with a reddish or blackish substance, which suggested that they might feed on wild birds or other vertebrates in nature (Sirivanakarn 1968).

MEDICAL IMPORTANCE. Little is known about the medical importance of *Lophoceraomyia.* In Malaysia, adults of some unidentified species have been reported to be naturally infected with 4 different arboviruses: Bakau (MM-2325), Ketapang (MM-2549) and Bebaru (MM-2354) and Lahore (a strain of Bakau No. 114)(Anonymous 1960, Berge 1970). It is probable that certain *Lophoceraomyia* species play an important role as a natural reservoir of arboviruses.

DISTRIBUTION. *Lophoceraomyia*, as far as known, is confined almost exclusively to the tropics and subtropics of the Oriental and Australasian regions, the islands of the western and central Pacific Ocean (Micronesia) and the South Pacific with a small extension into Japan, Korea and northern China in the Palearctic. Its westernmost limit appears to be in India and Pakistan and it has never been reported further to the west in the Middle East and the Ethiopian region. Of the 3 major groups, the *Fraudatrix* Group is the most widespread and has been recorded from all areas within the reported range of the subgenus. The *Mammilifer* Group is almost exclusively Oriental with only a few members occuring to the north in southern China, Taiwan and the Ryukyus and to the east as far as Papua New Guinea. The *Wilfredi* Group is exclusively Oriental, where it has been recorded only from Peninsular Malaysia, Thailand and southern China.

KEYS TO GROUPS OF ORIENTAL *LOPHOCERAOMYIA*

ADULTS

1. *Female:* Decumbent scales on dorsum of vertex largely broad; scales on veins R_2 and R_3 of wing usually broad, clavate; abdominal terga usually with basolateral pale spots or sometimes basal pale bands; *Male:* Basal segment 1 of palpus with 1 or 2 pairs of spiculose fingerlike processes; modified tufts of scales and setae present on flagellomeres 7-8 or 5-10.
FRAUDATRIX GROUP

Female: Decumbent scales on dorsum of vertex largely narrow, linear; scales on veins R_2 and R_3 of wing narrow, linear; abdominal terga completely dark or without pale markings as above; *Male:* Palpus without basal fingerlike processes; modified tufts of scales and setae present on flagellomeres 5-9 or 5-10 or completely absent. 2

2(1). *Male:* Antennal pedicel with spiculose prominence on inner dorsal surface; modified tufts of scales and setae usually present on flagellomeres 5-8 or 5-9; anterior surface of forefemur without a dense tuft of setae in apical half. . . . . *MAMMILIFER* GROUP

Male: Antennal pedicel without spiculose prominence on inner dorsal surface; modified tufts of scales and setae present on flagellomeres 5-10; anterior surface of forefemur with a dense tuft of several strong setae in apical half. . . *WILFREDI* GROUP

MALE GENITALIA

1. Dorsal lobe (DL) of lateral plate of phallosome (aedeagus) represented by a slender, simple, apical beaklike process, projecting tergally; ventral lobe (VL) prominent and very distinct in lateral aspects; proctiger crown relatively small. . *FRAUDATRIX* GROUP

Dorsal lobe (DL) of lateral plate of phallosome represented by a large denticulate or tuberculate external process (EP) and with or without a simple, spinelike internal process (IP); ventral lobe (VL) reduced and not as distinct as above; proctiger crown large. 2

2(1). Lateral plate of phallosome bowl-shaped, with a partially denticulate or tuberculate external process (EP) and a simple, spine-like internal process (IP). . . . . *MAMMILIFER* GROUP
Lateral plate of phallosome compact, barrel-shaped, with a broad, heavily denticulate external process (EP) only. *WILFREDI* GROUP

PUPAE

1. Trumpet short, bell-shaped or funnel-shaped, 0.2-0.4 mm in length; occurring in pitcher plants. *MAMMILIFER* GROUP (in part)
Trumpet long, cylindrical, 0.5-0.8 mm in length; occurring in ground pools, rock pools, tree holes, bamboos and leaf axils. . 2

2(1). Pinna of trumpet with slit extending into meatus. 3
Pinna of trumpet without slit extending into meatus. *MAMMILIFER* GROUP (in part)

3(2). Seta 5-IV double (except *mammilifer*, *wardi* and *bengalensis*). *MAMMILIFER* GROUP (in part)
Seta 5-IV 4-7 branched. 4

4(3). Seta 8-C single or double. . . . . *FRAUDATRIX* GROUP
Seta 8-C 4, 5 branched. . . . . *WILFREDI* GROUP

LARVAE

1. Setae 2, 3-A placed apically; setae 16, 17-C absent; breed in pitcher plants. . . . . *MAMMILIFER* GROUP (in part)
Setae 2, 3-A placed subapically; setae 16, 17-C present; breed in ground pools, rock pools, tree holes, bamboos and leaf axils. . 2

2(1). Seta 7-P triple (except *reidi*); seta 1-M 0.25-0.50 of the length of seta 3-M; breed in general ground pools. . *FRAUDATRIX* GROUP
Seta 7-P double; seta 1-M usually as long as seta 3-M; breed in rock pools, tree holes, bamboos, leaf axils or sometimes ground pools. 3

3(2). Seta 14-P double; usually breed in rock pools, tree holes, bamboos or sometimes leaf axils (except *mammilifer*, *bengalensis* and *pholeter*). . . . . *MAMMILIFER* GROUP
Seta 14-P single, breed in ground pools only. . . *WILFREDI* GROUP

FRAUDATRIX GROUP

FEMALE. As described for the subgenus; coloration varying from yellow, orange to dark brown, sometimes darker to almost black. *Head*. Decumbent scales of vertex relatively broad, clavate or ovate, occupying an extensive area in center, color of scales predominantly dark or sometimes with pale

ones forming a narrow ocular line; narrow decumbent scales rather few, largely restricted to dorsal midline of vertex and occiput; erect scales numerous, entirely dark brown or black; lateral patch of broad appressed scales partially pale to completely dark. Proboscis usually with 2 hairlike labial basal setae, sometimes 4-6, as long as or slightly longer than palpus. *Cibarial Armature.* Cibarial bar with 40-60 teeth in concave row, all teeth subequal in length and size and apically blunt. *Thorax.* Integument of mesonotum usually dark brown, sometimes pale yellow or orange; all mesonotal scales dark brown, sometimes few pale scales present, restricted to marginal areas on anterior promontory, humerus and scutal angle; pleural scale patches practically absent, sometimes with a few scattered scales on upper corner and posterior border of *stp; ppl* with 2, 3 dark bristles and a few other pale weak setae. *Wing.* Scales on veins R_2, R_3 usually broad, clavate, sometimes narrow, linear. *Abdomen.* All terga usually entirely dark, sometimes with basal pale bands or basolateral pale spots.

MALE. Generally similar to females except for scantier scales on wing veins and presence of more numerous *ppl* bristles. *Palpus.* Longer than proboscis by 0.5-1.0 of the length of segment 5; segment 1 usually with 1 or 2 pairs of conspicuous fingerlike processes; segment 3 with 1, 2 rows of short, tiny setae on ventral surface; segments 4 and 5 upturned, moderately to strongly plumose. *Proboscis.* Labial basal setae stout, spiniform, 8-12, in irregular transverse row on ventral surface; false joint present, usually marked by flexion at 0.25 from base, sometimes absent; apical 0.5 or more usually with a double row of sinuous setae on dorsal surface, sometimes absent. *Antenna.* Pedicel smooth, rounded, without nipplelike spiculose prominence on inner dorsal surface; flagellar whorls densely long plumose; modified tufts of scales and setae usually present on flagellomeres 5-10, sometimes 6-10 or restricted to flagellomeres 7-8; size and shape of modified tufts varied.

MALE GENITALIA. *Segment IX.* Tergal lobe with 3-4 weak setae; sternum usually entirely bare, sometimes with a few setae toward caudal margin. *Basimere.* Small, conical; bristles and setae on outer lateral surface rather sparse; inner tergal surface usually with differentiated submarginal setae, in a single row parallel to tergomesal margin, number and length varied. *Subapical Lobe.* Not clearly divided into proximal and distal divisions; proximal part with 3 stout rods *(a-c)* and usually 1 hairlike seta ventrad of seta *a;* setae of distal parts varied, usually with a mesal group of 4-6 bladelike setae *(d-f)* and 1 club-shaped leaflet (g_2) and a lateral group of 1 broad leaflet (g_1) and 1 strong basal seta *(h)*; sometimes leaflets (g_1, g_2) not developed or absent. *Distimere.* Normal; subapical portion very weakly serrated, without distinct crest of fine spicules extended to middle of curvature on dorsal surface; subapical claw, short, slender, distally dilate. *Phallosome.* Dorsal lobe of lateral plate in form of a beaklike process projecting tergad, which is simple or entirely bare (except for *infantulus* which is strongly imbricate with reticules); ventral lobe broad, prominent, with upper sternal margin at about same level of apical margin of dorsal beaklike process. *Proctiger.* Crown small, with relatively small number of spicules; apical and sternal lobes of paraproct poorly or well developed; cercal setae 2-3 in number.

PUPA. Cephalothorax and abdomen generally whitish or creamy white with indefinite darkened areas. *Trumpet.* Slender, relatively long and more or less cylindrical, length varies from 0.5-0.8 mm, index 10-18; pinna usually with slit extending to meatus. *Cephalothorax.* Setae 8, 9-C usually double, sometimes single or triple. *Metanotum.* Seta 11-C double. *Abdomen.* Seta 5-IV usually 4-6 branched (3-8); 5-V 2-5 branched; 5-VI usually double (1-3); 5-V, VI

shorter or as long as individual segment following; 6-III-VI 2-6 branched; 9-VII subequal in length to 9-VIII. *Paddle*. Usually entirely pale; midrib usually weak, pale, sometimes dark.

LARVA. *Head*. Integument yellowish white; seta 1-C stout, dark, simple spiniform; 4-C usually single or forked, short, usually 0.5 of distance between bases of the pair, sometimes shorter or longer; 5, 6-C strong, subequal; 5-C usually double, sometimes single or triple; 6-C always double. Antenna nearly as long as head; with numerous strong spicules on outer dorsal surface in basal 0.50-0.75 or more; seta 1-A large, fan-shaped, multibranched, placed at 0.75 of length from base; 2, 3-A bristlelike and dark, situated subapically. *Thorax*. Integument with or without conspicuous patch of spicules; seta 3-P usually single or double, sometimes multibranched; 4-P double or sometimes single; 7-P triple; 8-P subequal to 7-P, double; 14-P usually single, sometimes double; 1-M usually very short, inconspicuous, much shorter than 3-M, rarely as long as the latter. *Abdomen*. Spicules absent; live or whole mount specimens usually with light and dark greenish bands on segments I-VI; segments VII-VIII pale; setae 6-I, II pale, usually triple; 7-I pale, usually double, rarely single; 6-III-VI subequally long, 3-5 branched. Comb scales numerous, in broad oval patch, all scales small, subequal, apically rounded, with even fringe of fine spicules; seta 2-VIII usually double, sometimes single. Saddle complete; posterior caudal margin lightly spiculate; anal gills slender, usually longer than saddle. *Siphon*. Very slender, long, distally gradually tapered; 1.0-2.0 mm; index 8-12; siphon/saddle ratio usually 4, 5; pecten 8-14; subventral tufts 4 pairs (or total 8), all relatively weak, short, subequal, as long as or slightly longer than siphonal width at points of attachment; median caudal filament of spiracular apparatus well developed; seta 2-S weak, pale and short; ventral and dorsal valves of spiracle small.

DISCUSSION. The *Fraudatrix* Group in the broad sense occupies the entire reported range of the subgenus and is particularly common in the Oriental region (Southeast Asia), the Papuan part of the Australasian region and the South Pacific. Elsewhere, it has been reported from Australia [Edwards 1924; Dobrotworsky 1957 (1958)]; the western and central Pacific in Micronesia [Bohart 1956 (1957)] and from Japan in the eastern Palearctic (LaCasse and Yamaguti 1950).

Edwards (1932: 196-8) in his original scheme restricted the *Fraudatrix* Group to his group B *(Lophoceratomyia)*, but later (in Barraud 1934: 360-72) he expanded it to also include group A *(Minutissimus)*. The latter scheme was subsequently adopted by Colless (1965: 264) and is also followed here. The only modifications which I have made are to recognize 2 subgroups within this group: *Minutissimus* and *Fraudatrix* and to subdivide the second subgroup into 7 complexes. The 23 Oriental species are segregated according to the present scheme as follows: (1) *Minutissimus* Subgroup includes: *minutissimus* Theobald, *alorensis* n. sp. and *infantulus* Edwards; (2) *Fraudatrix* Subgroup represented by: (a) *seniori* complex with *seniori* Barraud, (b) *cinctellus* complex with *cinctellus* Edwards and *fulleri* (Ludlow), (c) *rubithoracis* complex with *rubithoracis* (Leicester), *niger* (Leicester) and *gibbulus* Delfinado, (d) *inculus* complex with *inculus* Colless, (3) *quadripalpis* complex with *quadripalpis* (Edwards), *aculeatus* Colless, *paraculeatus* n. sp., *aestivus* n. sp. and *reidi* Colless, (f) *variatus* complex with *variatus* (Leicester), *josephinae* Baisas, *cubitatus* Colless, *gracicornis* n. sp., *whartoni* Colless, *macdonaldi* Colless and *pairoji* n. sp. and (g) *alphus* complex with *alphus* Colless. For the accounts on the relationships among the various complexes and species, see the discussion of the subgroups.

KEYS TO SUBGROUPS, COMPLEXES AND SPECIES

FEMALES[1]

1. Abdominal terga with basal transverse pale bands. 2
   Abdominal terga entirely dark or with small basolateral pale spots (*Fraudatrix* Subgroup, in part). 3

2(1). Proboscis with 4-6 labial basal setae; plume scales on wing veins R_2, R_3 narrow, linear (*Minutissimus* Subgroup). (*minutissimus*, *alorensis* and *infantulus* inseparable, use male genitalia)
   Proboscis with 2 labial basal setae; plume scales on wing veins R_2, R_3 broad clavate or ovate (*Fraudatrix* Subgroup, in part). *cinctellus*

3(1). Small species, wing length 2.1-2.7 mm. 4
   Medium or large sized species, wing length 2.8-4.0 mm. 8

4(3). Integument of thorax yellowish, orange or golden; lower *mep* bristle absent. . . . . *rubithoracis*
   Integument of thorax brownish to blackish; lower *mep* bristle present. 5

5(4). Lower posterior *mep* with a minute patch of tiny semierect scale-like setae. . . . . *niger*
   Lower posterior *mep* without patch of setae as above. 6

6(5). Labial basal setae of proboscis strong, 6 in number. . . . . *alphus*
   Labial basal setae weak, 2 in number. 7

7(6). Abdominal terga with basolateral pale spots. . . . . *inculus*
   Abdominal terga without basolateral pale spots. . . . . *reidi*

8(3). Plume scales on wing veins R_2, R_3 relatively narrow, linear or clavate (*quadripalpis* complex). 9
   Plume scales on wing veins R_2, R_3 relatively broad, ovate. . . . 10

9(8). Wing length usually 3.4-3.7 mm (3.0-4.0 mm); cibarial armature with 60 teeth. . . . . *quadripalpis*
   Wing length usually less than 3.0 mm (2.7-3.0 mm); cibarial armature with 35-40 teeth. . . . . *aculeatus*

10(9). Acrostichal bristles present. . . . . *pairoji*
   Acrostichal bristles absent. 11

11(10). Inseparable, see key to males and male genitalia.
   fulleri, *variatus*, *josephinae*, *cubitatus*, *whartoni* and *macdonaldi*

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[1] *seniori*, *gibbulus*, *paraculeatus*, *aestivus* and *gracicornis* are unknown.

MALES AND MALE GENITALIA

1. Antennal flagellomeres 7 and 8 with inconspicuous mesal tufts of modified, stout spinelike or bristlelike setae; subapical lobe of basimere of genitalia without any leaflet (*Minutissimus* Subgroup). 2
Antennal flagellomeres 5-10 or sometimes 6-10 with distinct lateral, ventral and mesal tufts of modified scales and setae; subapical lobe of basimere of genitalia with at least 1 or usually 2 leaflets (*Fraudatrix* Subgroup). 4

2(1). Dorsal beaklike process of phallosome short, stout, and simple. . 3
Dorsal beaklike process of phallosome long, slender and strongly imbricate with reticules. . . . . *infantulus*

3(2). Dorsal beaklike process of phallosome with a posterior recurved spine sternad; proctiger crown with 14-17 dark spinelike spicules. . . . . *alorensis*
Dorsal beaklike process of phallosome without posterior recurved spine; proctiger crown with 4-5 pale toothlike spicules. . . . . *minutissimus*

4(1). Modified tufts of scales and setae poorly developed and restricted to antennal flagellomeres 6-10 only; apical half of proboscis without dorsal sinuous setae (*seniori* complex). . . . . *seniori*
Modified tufts of scales and setae well developed on antennal flagellomeres 5-10; apical half of proboscis usually with dorsal sinuous setae. 5

5(4). Antennal flagellomere 5 with a small tuft of narrow, hairlike setae or broad scales which are shorter or slightly longer than combined length of next 3 flagellomeres. 6
Antennal flagellomere 5 with a large fan-shaped tuft of several broad, blunt tipped scales which are as long as or longer than combined length of next 4 flagellomeres. 17

6(5). Basimere of genitalia stout, swollen or convex on tergomesal margin and with a dense group of several strong submarginal setae in patch. 7
Basimere of genitalia slender, with concave tergomesal margin and relatively few strong submarginal setae in a single regular row. 9

7(6). Dorsal process of lateral plate of phallosome anvil-shaped, with numerous toothlike ridges (*inculus* complex). . . . . *inculus*
Dorsal process of lateral plate of phallosome beaklike and simple (*cinctellus* complex). 8

8(7). Submarginal setae of basimere relatively weak, subequal and more or less widespread; leaflets g_1, g_2 of subapical lobe moderately broad. . . . . *cinctellus*

Submarginal setae of basimere strong and densely packed, 4-5 basal ones very strong, remaining weaker and subequal; leaflets g_1, g_2 of subapical lobe very broad. . . . . *fulleri*

9(6). Modified tuft of antennal flagellomere 5 rather inconspicuous, consisting of narrow, flattened, fine tipped setae only (*rubithoracis* complex). 10

Modified tuft of antennal flagellomere 5 very conspicuous, consisting of some broad, dark scales and fine tipped, flattened setae (*quadripalpis* complex). 12

10(9). Proboscis without dorsal sinuous setae; paraproct of proctiger with a long, apical thumblike lobe. . . . . *niger*

Proboscis with dorsal sinuous setae; paraproct of proctiger with a short, pointed or rounded apical lobe. 11

11(10). Distal division of subapical lobe elongate, leaflet g_1 absent; basimere with 1 submarginal seta. . . . . *gibbulus*

Distal division of subapical lobe not elongate, leaflet g_1 present; basimere with a row of 3 submarginal setae. . . . *rubithoracis*

12(9). Basimere with a prominent row of 7-8 long submarginal setae. . . . . *quadripalpis*

Basimere with a weak row of 2-4 short submarginal setae. . . . 13

13(12). Submarginal setae strong, flattened, usually 4 in number; one of rodlike *a-c* of subapical lobe with characteristically expanded apex (Fig. 18). . . . . *reidi*

Submarginal setae weak, fine, hairlike, 1-3 in number; none of rodlike *a-c* of subapical lobe with modified apex as above. . . 14

14(13). Basimere with 3 strong submarginal setae. 15

Basimere with 1 weak submarginal setae. . . . . *aestivus*

15(14). Dorsal beaklike process of lateral plate of phallosome slender, thin and remarkably long; antennal flagellomere 7 with well developed comb-shaped tuft of modified setae. . . . . *aculeatus*

Dorsal beaklike process of lateral plate of phallosome stout and relatively short; antennal flagellomere 7 with poorly developed comb-shaped tuft of modified setae. . . . . *paraculeatus*

16(5). Small, wing length at most 2.6 mm; modified tuft of antennal flagellomere 5 with scales in ventral group strongly expanded or swollen toward apices (*alphus* complex). . . . . *alphus*

Medium or large, wing length more than 2.8 mm or usually 3 mm; modified tuft of antennal flagellomere 5 without scales in ventral group modified as above (*variatus* complex). 17

17(16). Modified tuft of fused setae of antennal flagellomere 8 with characteristic kink toward apical J-hook; humerus and anterior margin of fossa of mesonotum with a dense patch of numerous setae. . 18

Modified tuft of fused setae of antennal flagellomere 8 in form of a typical, smooth J-hook; humerus and anterior margin of fossa

without a distinct patch of setae. 19

18(17). Dorsal beaklike process of lateral plate of phallosome slender, long, sustaining about 90 degrees with main stem. . . . *variatus*
Dorsal beaklike process of lateral plate of phallosome stout, short, and strongly bent, forming an acute angle with main stem. . . . . *josephinae*

19(17). Basimere with a prominent row of 6, 7 strong submarginal setae. . . . . *pairoji*
Basimere with a weak row of 3-4 weaker submarginal setae. . . . 20

20(19). Modified tuft of antennal flagellomere 5 largely composed of very broad dark scales only. . . . . *whartoni*
Modified tuft of antennal flagellomere 5 composed of broad dark scales dorsally and narrow, pale scales or flattened setae laterally and ventrally. 21

21(20). Seta *a* of subapical lobe characteristically elbowed in apical half. . . . . *cubitatus*
Seta *a* of subapical lobe straight or uniformly smooth, without above modification. 22

22(21). Submarginal setae of basimere usually 4 in number; basal processes of palpal segment 1 long. . . . . *macdonaldi*
Submarginal setae of basimeres 3 in number; basal processes of palpal segment 1 relatively short. . . . . *gracicornis*

PUPAE[1]

1. Setae 6-III-IV 5, 6 branched (*Minutissimus* Subgroup). *minutissimus*, *infantulus*
Setae 6-III-IV usually 1-4 branched (*Fraudatrix* Subgroup). 2

2(1). Seta 10-C single. . . . . *alphus*
Seta 10-C double or more branched. 3

3(2). Seta 9-C usually 3, 4 branched; seta 10-C 3, 4 branched. . *cinctellus*
Seta 9-C single or double; 10-C double. 4

4(3). Seta 5-V usually 5, 6 branched; 6-IV-VI usually 4-6 branched. . . 5
Seta 5-V usually double or at most 4 branched; 6-IV-VI usually 2-4 branched. 6

5(4). Seta 7-II usually triple; 9-VII usually 4, 5 branched. . . *quadripalpis*
Seta 7-II usually double, 9-VII usually triple. . . . . *aculeatus*

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[1] *alorensis* not included; *seniori*, *fulleri*, *gibbulus*, *paraculeatus*, *aestivus* and *gracicornis* unknown.

6(4). Seta 8-C single. . . . . *whartoni*
Seta 8-C double. 7

7(6). Seta 1-C double; 6-IV, V usually double. 8
Seta 1-C triple or 4 branched; 6-IV, V 3, 4 branched. 10

8(7). Seta 5-II 5 branched; 5-III 4, 5 branched. . . . . *cubitatus*
Seta 5-II 3, 4 branched; 5-III 3, 4 branched. 9

9(8). Integument dark brown; seta 5-IV 4, 5 branched. . . . . *inculus*
Integument pale yellowish; seta 5-IV double or triple. . . . . *reidi*

10(7). Integument dark brown or with striking pattern of dark and light areas; seta 5-IV usually 7 branched. 11
Integument more or less uniformly pale yellowish or without striking pattern of dark and light areas; seta 5-IV usually 6 branched. 12

11(10). Cephalothorax and abdomen entirely dark brown; paddle with dark and very strong midrib. . . . . *niger*
Cephalothorax and abdomen with pattern of dark brown and pale areas; paddle with pale and weak midrib. . . . . *rubithoracis*

12(11). Margin of mid-dorsal ridge of cephalothorax strongly folded or very irregular; seta 4-VIII usually double. . *macdonaldi, pairoji*
Margin of mid-dorsal ridge of cephalothorax weakly folded or more or less regular; seta 4-VIII usually triple. 13

13(12). Seta 5-V 3, 4 branched. . . . . *variatus*
Seta 5-V double. . . . . *josephinae*

LARVAE[1]

1. Seta 2-VIII single; 14-P double (*Minutissimus* Subgroup). *minutissimus, infantulus*
Seta 2-VIII double; 14-P usually single (*Fraudatrix* Subgroup). . . 2

Fraudatrix Subgroup

2(1). Seta 4-P single. 3
Seta 4-P double. 6

3(2). Seta 5-C single (*inculus* complex). . . . . *inculus*
Seta 5-C double (*quadripalpis* complex). 4

4(3). Seta 7-P usually double; 7-I single. . . . . *reidi*
Seta 7-P triple; 7-I double. 5

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[1] *alorensis*, not included; *seniori, fulleri, gibbulus, paraculeatus, aestivus* and *gracicornis* unknown.

5(4). Seta 3-P usually double; each siphonal tuft usually double. *aculeatus*
Seta 3-P usually single; each siphonal tuft 3, 4 branched. *quadripalpis*

6(2). Seta 5-C triple (*cinctellus* complex). . . . . *cinctellus*
Seta 5-C double or single. 7

7(6). Pecten teeth simple or with inconspicuous fringe of numerous fine spines; comb scales strongly differentiated into an anterior group of short ones and a posterior row of remarkably long ones (*alphus* complex). . . . . *alphus*
Pecten teeth with distinct fringe of strong denticles; all comb scales similar in length and size. 8

8(7). Seta 5-C single. . . . . *niger*
Seta 5-C double. 9

9(8). Seta 3-P multiple or at least 4 branched; 7-I single. . . *rubithoracis*
Seta 3-P single or double or at most 4 branched; 7-I double (*variatus* complex). 10

10(9). Seta 14-P usually double; 2-X of saddle double. . . . . *cubitatus*
Seta 14-P single; 2-X of saddle 3, 4 branched. 11

11(10). Seta 3-P 3, 4 branched; 4-C longer than distance between bases of the pair. . . . . *whartoni*
Seta 3-P single or double; 4-C at most 0.5 as long as distance between bases of the pair. 12

12(11). Seta 9-C larger than 8-C and placed at a considerable distance cephalad of the latter. . . . . *macdonaldi*
Seta 9-C subequal to 8-C and placed slightly cephalad of the latter. 13

13(12). Setae 4 and 10-VII usually triple. . . . . *pairoji*
Setae 4 and 10-VII double. 14

14(13). Seta 3-P usually double. . . . . *variatus*
Seta 3-P usually single. . . . . *josephinae*

Minutissimus Subgroup

The *Minutissimus* Subgroup is characterized chiefly by the following characters: in the adults of both sexes by (1) presence of basal transverse pale bands on abdominal terga II-VII and (2) plume scales of veins R_2, R_3 of wing rather narrow, linear; in the female by proboscis with 4-6 labial basal setae; in the male by (1) palpal segment 1 with rudimentary basal spiculose processes; (2) palpal segments 4, 5 weakly plumose or with rather few lateral and mesal bristles; (3) proboscis without dorsal upright sinuous setae and (4) modified tufts of setae present only on mesal surface of antennal flagellomeres 7 and 8; in the male genitalia by (1) distal division of subapical lobe without leaflets;

(2) submarginal setae of basimere poorly differentiated and widely spaced; (3) phallosome with single beaklike process on dorsal lobe of lateral plate and (4) proctiger with a small crown of few to several spinelike spicules; in the pupa by (1) long, slender trumpet; (2) pinna of trumpet with slit extending to meatus; (3) setae 10, 11-C double; (4) seta 5-IV 4-8 branched and (5) setae 6-III-VI 5, 6 branched; in the larva by (1) seta 4-C 1.0-1.5 times as long as distance between bases of the pair; (2) seta 5, 6-C double; (3) seta 3-P usually single; (4) seta 14-P double; (5) seta 7-I double; and (6) seta 2-VIII single.

DISCUSSION. The *Minutissimus* Subgroup is a complex of 3 species: *minutissimus*, *alorensis* and *infantulus*. The first 2 of these are apparently restricted in distribution; *minutissimus* is known only from Sri Lanka, India and Thailand and *alorensis* from Alor, Indonesia while *infantulus* is widespread with the range extending north and northeast into Japan and possibly also China and Korea in the Palearctic.

The relationships between the *Minutissimus* and *Fraudatrix* Subgroups are not clear, but both apparently fall into the same phyletic line (*Fraudatrix* Group) on the basis of the phallosome of the male genitalia and the multitude of characters of the immature stages. Colless (1967: 519-20), in discussing the affinity of *infantulus*, pointed out that it does not fit either to the *Fraudatrix* (group A) or the *Mammilifer* (group B) and suggested its placement in a third group. This view is not justified since the other 2 members, *minutissimus* and *alorensis*, do show the *fraudatrix*-type of male phallosome. In fact, the male phallosome of *infantulus* is only slightly modified, especially in being strongly reticulate, but its shape essentially resembles the other 2 related species and all known members of the *Fraudatrix* Group. On the other hand, the presence and the development of modified setal tufts on male antennal flagellomeres 7 and 8 in the *Minutissimus* Subgroup are, somewhat surprisingly, identical to those of the *Digoelensis* Subgroup of the *Mammilifer* Group in New Guinea (Sirivanakarn 1968: 101-6). The *Minutissimus* larvae resemble most members of the *Mammilifer* Group by having seta 14-P double and seta 2-VIII single, as noted by Colless (1967) for *infantulus*, but generally conform to the *Fraudatrix* Group in most features of the chaetotaxy.

1. *CULEX (LOPHOCERAOMYIA) MINUTISSIMUS* (THEOBALD)
(Fig. 1)

Culiciomyia minutissima Theobald 1907: 235 (♀).
Culiciomyia nigerrima Theobald 1910: 233 (♀); Edwards 1913: 235 (synonymy).
Melanoconion juxtapallidiceps Theobald 1910: 456 (♀); Edwards 1913: 235 (synonymy).
Culex (Lophoceratomyia) minutissimus (Theobald), Edwards 1922a: 280 (♂*, key); Barraud 1924: 39 (♂*, ♀, L); Senior-White 1927: 71 (L*); Edwards 1932: 197 (taxonomy); Barraud 1934: 363 (♂*, ♀, L); Feng 1938: 299 (distribution); Brug and Bonne-Wepster 1947: 186 (distribution).
Culex (Lophoceraomyia) minutissimus (Theobald), Stone, Knight and Starcke 1959: 234 (catalog); Harrison et al. 1974: 156 (distribution).

FEMALE. Wing: 2.8 mm. Forefemur: 1.3 mm. Proboscis: 1.6 mm. Small species; essentially conforms to the description of the *Fraudatrix* Group with the following diagnostic features. *Head*. Decumbent scales on dorsum of vertex largely broad and entirely dark, not forming pale ocular line anteriorly; erect scales slender, entirely dark; lateral patch of broad scales dingy

white or dark bluish. Palpus dark scaled; 0.15-0.20 of proboscis length. Proboscis dark scaled; labial basal setae 4-6, 2 lateral ones longest, as long as palpus. *Cibarial Armature*. Not studied. *Thorax*. Mesonotal integument dark; scales narrow, dark except for a few pale ones on extreme anterior promontory, humerus and scutal angle. Pleural integument without pattern of dark and pale bands; scales practically absent; *ppl* with 2 dark, strong bristles and 3-4 pale, weak setae; 1 lower *mep* bristle present. *Legs*. Anterior surface of hindfemur entirely dark. *Wing*. Plume scales on veins R_2, R_3, R_{4+5} and branches of M and Cu narrow, linear and fine. *Abdomen*. Terga II-VI with narrow, complete basal pale bands; sterna entirely dark or with banding pattern as terga.

MALE (Fig. 1). In general similar to female except for the following sexual characters. *Palpus*. Slender, exceeding proboscis length by 0.5-1.0 of segment 5; segment 1 with a mesal pair of basal processes which are rudimentary and rather inconspicuous; segments 4, 5 upturned, very weakly plumose or with only a few bristles; apex of segment 5 bears 1, 2 slender, dark spines. *Proboscis*. False joint submedian, not clearly marked; apical 0.5 of labium without upright setae on dorsal surface; labial basal setae 8-10, all dark, weak, long, hairlike, as in female. *Antenna*. Pedicel rounded, without prominence; flagellum densely long plumose, with small modified tuft of setae only on flagellomeres (F) 7 and 8, both mesal in position, readily seen from above; F-7 with a minute tuft of 2, 3 short, dark stout setae; F-8 with a strong tuft of 3-4 long, dark bristlelike setae, as long as combined length of next 3 flagellomeres; F-12 about 1.5 times as long as F-13.

MALE GENITALIA (Fig. 1). *Segment IX*. Tergum narrow, ribbonlike; tergal lobe very small, bearing 2, 3 weak setae; sternum broad, without setae or scales. *Basimere*. Small, slender, conical, 0.20-0.25 mm. in length; submarginal setae 2-6, widely spaced, in row parallel to tergomesal margin. *Subapical Lobe*. Proximal rodlike setae *a-c* stout, straight, apically hooked, 1 of which is thicker and broader than the other 2; weak seta present or absent, ventrad of seta *a*; distal part not clearly separated from proximal part; setae *d-f* 4, 5, all subequal, flattened, bladelike, 0.75 of length of setae *a-c*; leaflets g_1, g_2 absent; seta *h* and 1, 2 other weak setae present, laterad of setae *d-f*. *Distimere*. Short and slender, about 0.5 of the length of basimere; basal 0.5 straight and uniformly broad, apical 0.5 slightly curved downward and tapered into a blunt apex; subapical claw slender and moderately long; dorsal and ventral tiny setae present beyond middle of curvature, dorsal distad of ventral. *Phallosome*. Dorsal process simple, beaklike, more or less resembling duck head; ventral lobe large and rounded on apical sternal margin. *Proctiger*. Apical crown very poorly developed, consisting of 4-6 toothlike spicules, in single row; paraproct broad and strongly sclerotized, apical portion in form of a broad plate; cercal sclerite broad and well sclerotized; cercal setae 4.

PUPA. Abdomen: 2.5 mm. Paddle: 0.67 mm. Trumpet: 0.65 mm; index 10. As figured for *infantulus* (Fig. 2). In general as described for the group and subgroup with the following diagnostic chaetotaxy. *Cephalothorax*. Seta 1-C 4, 5 branched; 3-C usually triple (2-4); 5-C usually 5 branched (4-6); 8, 9-C double. *Metanotum*. Seta 10-C usually triple (2-3); 11-C double. *Abdomen*. Seta 5-IV 4-8 branched; 5-V usually double, sometimes triple; 6-III-VI 5, 6 branched; 9-VII usually triple (2-4); 4-VIII double; 9-VIII usually 6, 7 branched (4-7). *Paddle*. Broad, pale to almost transparent; midrib variable, from very weak, pale to strong and dark pigmented.

LARVA. Head: 0.65 mm. Siphon: 1.6 mm; index 8-10. Saddle 0.3 mm; siphon/saddle ratio 5-6. As figured for *infantulus* (Fig. 3). *Head*. Seta 1-C

dark, stout, spiniform; 4-C double or single, long, 1.0-1.5 times as long as distance between bases of the pair; 5, 6-C strong, as long as antenna, double; 7-C usually 7 branched (5-7); 10-C double or triple; 13-C 5, 6 branched; 14-C usually double (2-3). Antenna. Nearly as long as head; pigmentation largely pale, cream-colored proximally, dark at base and beyond the insertion of seta 1-A; spicules numerous and distinct. *Thorax.* Spiculation absent; seta 3-P usually double, sometimes single; 4-P double; 7-P triple; 8-P double, strong; 14-P double. *Abdomen.* Live specimens with dark greenish bands on segments I, II, III, V and VI, largely pale on segments IV and VIII; setae 6-I, II triple; 7-I double; 6-III-VI 4 branched; 1-III-VI usually 3, 4 branched (3-5); seta 1-VII usually 6 branched (4-8); 4 and 7-VII single; 13-VII 4 branched. Comb scales about 40, in broad oval patch; all scales similar, subequal in length and size and with rounded apical fringe of evenly fine spicules; seta 1-VIII usually 5 branched (4-6); 2-VIII single; 3-VIII 7, 8 branched; 5-VIII 4, 5 branched. Saddle same color as pale portion of siphon; spiculation very weak; seta 1-X usually triple (2-4); 2-X 3, 4 branched; anal gills slender, pale, fusiform, as long as or slightly longer than dorsal length of saddle. *Siphon.* Slender, straight, long, distally tapering and with median dark ring; pecten teeth 12-14, most distal tooth with 6, 7 graded denticles; subventral tufts weak and short, 4 pairs (or total 8), double or triple each, as long as siphonal width at points of attachment.

TYPE-DATA. (1) *Culiciomyia minutissima* Theobald; Holotype ♀*, CEYLON [SRI LANKA], *Peradeniya*, date not specified, collected by Green, British Museum (Natural History) (BMNH). (2) *Culiciomyia nigerrima* Theobald; Holotype ♀*, CEYLON [SRI LANKA], Trincomalee, October 1907, collected by Green (BMNH). (3) *Melanoconion juxtapallidiceps* Theobald; Holotype ♀*, CEYLON [SRI LANKA], Trincomalee, October 1907, collected by Green (BMNH).

DISTRIBUTION. Known only from India, Sri Lanka and Thailand. 31 specimens examined: 10♂, 14♀, 1 P, 6 L; 8 with associated immature skins (7 p, 1 lp).

INDIA. *Bombay:* Trombay; Karanja Jungle; Coimbatore; 5♂, 2♀, 1 P, 5 L (P. J. Barraud, 1921).

SRI LANKA. Colombo; Padaviya; Peradeniya; Trincomalee; 2♂, 6♀ (including 3♀ in the type-data), 1 L, 1 lp.

THAILAND. *Phrae:* Padaeng Khawi; 3♂, 6♀, 7 p.

Additional records from the literature: INDIA, Bombay: Deccan; Hubli; Madras: Nilgiri Hills; Central Province: Nowgong; Orissa; Punjab (Barraud 1924: 41; 1934: 365); CHINA, Kwangtung (Feng 1938: 299).

TAXONOMIC DISCUSSION. *Culex minutissimus* is identical to *alorensis* and *infantulus* in the male antenna and in the general external characters of the adults. It can be definitely separated from the latter 2 species by the shape of the male phallosome and by the details of the proctiger as indicated in the key and as described and figured here. In the immature stages, the *minutissimus* pupa differs slightly from that of *infantulus* in having most setae relatively stronger and longer; seta 10-C usually triple (usually double in *infantulus*) and seta 5-V usually double (usually 3, 4 branched in *infantulus*). The larva differs from *infantulus* in having seta 6-III 4 branched (triple in *infantulus*) and in the presence of a median dark ring on the siphon (usually absent in *infantulus*).

Except for the localities given above in the distribution data, most of the previous records of *minutissimus* in the literature are doubtful and require confirmation. The record from Vietnam by Borel (1930: 352-6) is undoubtedly

erroneous judging from the figures and the description of the male phallosome and proctiger by this author. It appears most likely that Borel's specimens are in fact those of *infantulus* which is more common and more widespread in the Oriental region.

BIONOMICS. *Culex minutissimus* is a typical ground pool breeder. In India it was reported from rock springs, pools in ravine and river-beds, coconut shells, shallow wells, stagnant water in shaded culverts, etc. (Barraud 1934: 364-5). In Sri Lanka, the immatures were collected from ground pools without further particulars. In Thailand, the pupae were collected from flooded pools in mountain areas. The adults came from rearing the pupae or larvae and were also caught by sweep nets near the water sources. The adult biology is unknown.

2. *CULEX (LOPHOCERAOMYIA) ALORENSIS* NEW SPECIES
(Fig. 1)

Culex (Lophoceratomyia) minutissimus of Brug and Bonne-Wepster 1947: 186 (misidentification).

FEMALE. Small, light brown species; wing length about 2.7 mm. Essentially similar to *minutissimus* and *infantulus* in the presence of basal pale bands on abdominal terga II-VII, differing slightly in the following features. *Head*. Decumbent scales on dorsum of vertex narrower and predominantly pale, forming distinct ocular line; lateral patch of broad scales whitish, apparently broader and more distinct. *Thorax*. Integument of mesonotum pale brown or yellowish brown but not blackish or reddish; mesonotal scales same color as underlying integument.

MALE (Fig. 1). Essentially similar to *minutissimus* and *infantulus* in palpus, proboscis and antennal characters, differing as described for female and in the following additional features. *Palpus*. Variable in length, from slightly shorter to longer than proboscis by length of segment 5. *Antenna*. Flagellar whorls weakly to moderately plumose. *Abdomen*. Basal pale bands usually well developed and distinct on terga IV-VII or V-VII, poorly developed and indistinct on terga II-III or II-IV, latter sometimes completely dark scaled or with only a few pale scales forming basolateral pale spot

MALE GENITALIA (Fig. 1). As figured; extremely similar to *minutissimus*, differing from it particularly in the following features. *Basimere*. Inner tergal surface with 1 strong seta in line with 2, 3 other weaker setae. *Subapical Lobe*. Seta *h* of distal part stronger and longer; setae *d-f* consist of 3 subequal, sharply pointed blades and 2 shorter and weaker hairlike setae. *Distimere*. Subapical claw longer; its apex strongly inflated or expanded. *Phallosome*. Dorsal beaklike process more slender, shorter and with a recurved spine on posterior margin. *Proctiger*. Apical crown with a dense tuft of several dark spinelike spicules; paraproct narrow with small rounded apical lobe; cercal setae 3 in number.

PUPA. Abdomen: 2.2 mm. Paddle: 0.56 mm. Trumpet: 0.55 mm; index 10-11. Essentially similar to *minutissimus* and *infantulus* in general and in detailed chaetotaxy, differing in the following combination of characters. *Cephalothorax*. Seta 8-C usually triple (2-3); 9-C single or double. *Abdomen*. Seta 1-III usually 7 branched (6-9); 1-IV usually 7 branched (5-8); 1-V usually 5 branched (3-6); 1-VI, VII usually triple (3-4); 5-IV usually triple (3-4); 5-V usually double (1-2); 6-III usually triple (2-4); 6-IV-VI

usually 3, 4 branched (3-5).

LARVA. Head: 0.65 mm. Siphon: 1.6 mm; index 8-9. Saddle: 0.30 mm; siphon/saddle ratio 6. Essentially similar to *minutissimus* and *infantulus* and as figured for the latter (Fig. 3), differing from both particularly in the following. *Thorax.* Seta 7-P usually double (1-2); 8, 9-M usually 4 branched (4-5). *Abdomen.* Setae 1-III-VI usually triple (2-3); 6-IV-VI triple; 1-VII usually 4 branched (3-4). Saddle seta 2-X double. *Siphon.* Yellowish white, median dark ring absent.

TYPE-DATA. Holotype ♂ (80-65) with slide of antenna and genitalia (69/297), INDONESIA, *Alor*, date not specified, collected by Rodenwaldt, U. S. National Museum (USNM). Paratypes: 1♂ (80-63) with slide of antenna and genitalia (69/299) and 1♂ (80-62) with attached genitalia mount on pin, *Pantar*, June 1925, collected by Von Beck (USNM); 2♂, (TM-0047), 2 lp♀ (TM-004702, 14) (USNM), 2♂ (TM 0047), 2 lp♀ (TM 0047-1, 2) and 2♀ (TM 0047) (J. C. Lien coll., Taiwan), *Timor*, Halibot, larvae in stream pool, 6-7 October 1973, J. C. Lien and Soeroto, collectors.

DISTRIBUTION. Known only from Alor, Pantar and Timor, Indonesia. 13 specimens examined: 7♂, 6♀; 4 with associated larval and pupal skins.

INDONESIA. *Alor* (type-locality); 1♂ (holotype), as indicated in the type-data; *Pantar;* 2♂ (paratypes), as indicated in the type-data; *Timor:* Halibot, Malak Timur, Belu Reg. 4♂, 6♀, 4 lp; (all designated as paratypes); reared from larvae collected in stream pool, 6-7 October 1973, J. C. Lien and Soeroto.

TAXONOMIC DISCUSSION. *Culex alorensis* was previously recorded by Brug and Bonne-Wepster (1947: 186) as *minutissimus* based on the adult males from Alor and Pantar. Preliminary study of this material and subsequent study of the specimens recently reported by Lien et al. [1975: 335 as *Culex (Lophoceraomyia)* sp.] from Timor has shown that it is distinct from *minutissimus* and *infantulus* in the shape of the phallosome and in the development of the proctiger crown of the male genitalia. It is also quite possible that the record of *minutissimus* by Brug and Bonne-Wepster (loc. cit.) from Sulawesi (Celebes) is in fact that of *alorensis*.

Culex alorensis is closely related to *minutissimus* and *infantulus* and with the latter 2 species, falls into the *Minutissimus* Subgroup as recognized here. The male phallosome and proctiger of *alorensis* are apparently more similar to members of the *Fraudatrix* Subgroup than to that of *minutissimus* and *infantulus*.

BIONOMICS. The specimens from Alor and Pantar presumably came from a general field catch but no definite field data were given. In Timor, immatures were collected in a stream pool. Nothing is known about the adult biology of *alorensis*.

3. *CULEX (LOPHOCERAOMYIA) INFANTULUS* EDWARDS

(Figs. 2, 3)

Culex (Lophoceratomyia) infantulus Edwards 1922a: 287 (♂*, ♀, key); Edwards 1932: 197 (taxonomy); Baisas 1935: 174 (♂*); Causey 1937: 416 (distribution); Feng 1938: 298 (distribution); LaCasse and Yamaguti 1950: 197 (♂*, ♀*, P*, L*); Brug and Bonne-Wepster 1947: 186 (distribution).

Culex (Lophoceraomyia) parainfantulus Menon 1944: 389 (♂, ♀); Mattingly 1949: 224 (synonymy).

Culex (Lophoceraomyia) infantulus Edwards, Bohart 1945: 75 (♂, L); Bohart and Ingram 1946: 73 (♂*, ♀, L*, P*); Iyengar and Menon 1955: 10 (L*); Peters and Dewar 1956: 46 (L); Stone, Knight and Starcke 1959: 233 (catalog); Delfinado 1966: 106 (♂*); Colless 1967: 519 (taxonomy); Bram 1967a: 58 (♂*, ♀, L*); Baisas 1974: 111 (♂, ♀, P, L); Harrison et al. 1974: 156 (distribution).
Culex (Lophoceratomyia) minutissimus of Borel 1930: 353 (misidentification).

FEMALE. Wing: 2.3-2.8 mm (average 2.6 mm). Forefemur: 1.4 mm. Proboscis: 1.7 mm. Abdomen: 1.6-2.3 mm. Small, blackish species; as described and figured by LaCasse and Yamaguti (1950: 197-9) and Bram (1967a: 55-61). In general extremely similar to *minutissimus* from which it can not be separated with certainty. *Cibarial Armature* (Fig. 2). Cibarial bar with about 60 narrow, long, apically blunt teeth in an even concave row. *Legs*. Anterior surface of hindfemur usually with pale whitish stripe, sometimes entirely dark. *Abdomen*. Basal transverse pale bands of abdominal terga variable, usually broad, sometimes narrow or incomplete.

MALE. Essentially similar to *minutissimus* and *alorensis* in palpal, labial and antennal characters and cannot be separated from the latter 2 species with certainty.

MALE GENITALIA (Fig. 2). As figured, differing strikingly from *minutissimus* and *alorensis* in the phallosome and slightly in other features as in the following. *Basimere*. Submarginal setae 5, 6 in number, 3 of which are strong, subequal in length, 2 or 3 other setae weaker and shorter. *Subapical Lobe*. Setae *a-c* subequal in length and thickness. *Distimere*. Subapical claw slender, long, as in *alorensis*. *Phallosome*. Dorsal beaklike process of lateral plate slender, long, largely reticulose or strongly imbricate with numerous reticules. *Proctiger*. Apical crown larger, consisting of numerous dark spinelike spicules; paraproct narrow, weakly sclerotized, without distinct apical lobe; cercal setae 3-5.

PUPA (Fig. 2). Abdomen: 2.4-2.8 mm (average 2.6 mm). Paddle: 0.52-0.69 mm (average 0.65 mm). Trumpet: 0.56-0.78 mm (average 0.65 mm); index 9-12. As figured; extremely similar to *minutissimus*, differing in having most setae relatively weaker and particularly in the following. *Metanotum*. Seta 10-C usually double (2-3). *Abdomen*. Seta 5-V usually 3, 4 branched (2-4); setae 6-III-VI usually 5, 6 branched, sometimes 3, 4 branched.

LARVA (Fig. 3). Head 0.65-0.78 mm (average 0.72 mm). Siphon 1.5-2.0 mm (average 1.8 mm); index 8-10. Saddle 0.27-0.34 mm (average 0.3 mm); siphon/saddle ratio 5-6. As figured, differing slightly from *minutissimus* particularly in the following. *Thorax*. Seta 3-P single or double; 4-P usually triple, sometimes 4 branched. *Abdomen*. Seta 6-III usually triple (3-4). *Siphon*. Median dark ring usually absent or sometimes median portion slightly darkened, but not forming a distinct ring.

TYPE-DATA. (1) *Culex (L.) infantulus* Edwards 1922; Holotype ♂* with attached genitalia mount; HONG KONG, 1914, collected by Dr. H. Macfarlane (BMNH). (2) *Culex (L.) parainfantulus* Menon; Type (not specified); INDIA, Trivandrum, *Travancore* (Madras states), location of the type unknown.

DISTRIBUTION. Widely distributed throughout the Oriental region. 548 specimens examined: 259♂, 193♀, 7 P, 89 L; 248 with associated immature skins (138 p, 110 lp).

INDIA. *Bombay:* Kawar, N. Kanara; 1♂, 1♀.
NEPAL. Hetaura; 4♂.
MALDIVE ISLANDS: Fiori; 1♂.

BURMA. *Rangoon;* 5♂.

SRI LANKA. *North Central Province:* Anuradhapura, Padaviya; 1♂.

THAILAND. *Mae Hong Son:* Doi Chang; Mae Sariang; *Chiang Mai:* Muang; Chom Tong; Huey Kaeo; Chang Phuak; Ban Chang Kien; San Kampang; Ban Rong Rua Taeng; Ban San Kha Yom; *Nan:* Na Noi; Ban Pong Mon; *Lampang:* Ngao; Ban Pha Khoi; Ban Pha Daeng; Ban Rong; Ban Rong Pako; Ban Rong Na; Ban Pha Khoi; *Nakhon Ratchasima:* Koraj, Pachong; Huey Sai Noi; *Prachin Buri:* Ban Thap Lan; Ban Bu Phram; *Chanthaburi:* Tha Mai; Ban Plu; *Nontha-buri; Ayutthaya:* Bang Pa-In; *Chon Buri:* Bang La Mung; Khao Mai Kaeo; Khao Mai Hawa; *Prachuab Khiri Khan:* Khlong Hin Chong; *Krabi:* Ban Mai Kien Tai; Ban Pru Taci; *Surat Thani:* Koh Samui; *Pathum Thani; Satun;* 123♂, 107♀, 42 L, 142 p, 40 lp.

VIETNAM. Cam Ranh; 2♂, 3 L.

MALAYSIA. *Peninsular Malaysia* (Malaya): *Serdang; Perak:* Pusing; Kuala Kangsar; *Kedah:* Changlum; *Perlis:* Kg. Sanglang; 20♂, 15♀, 8 L, 19 lp.

PHILIPPINES. *Luzon:* Agoo La Union; Subic Naval Base; Malawin Creek, Mt. Makiling; *Mindoro:* San Jose; *Samar:* Osmena; *Leyte:* Palo; Lago Lago, Baybay; *Mindanao:* Parang; Zambales; 34♂, 35♀, 13 L, 49 lp.

HONG KONG. 4♂, 4♀.

JAPAN. *Ryukyu Islands - Okinawa:* Chizuka; Kana village; Nakasoni; Nago; Iriomote: 1.5 mi. N. Toyokara village; Yabu; 40♂, 13♀, 10 L, 3 lp; *Nagasaki; Honshu; Kyoto;* 5♂, 3♀, 4 L.

Additional records from the literature: INDONESIA, Java (Brug and Bonne-Wepster 1947: 186); CHINA, Anhwei, Chekiang, Kiangsi, Kwangtung (Feng 1938: 298).

TAXONOMIC DISCUSSION. *Culex infantulus* is one of the most widespread forms of *Lophoceraomyia* in the Oriental region. It occurs sympatrically with *minutissimus* in northern Thailand, southern India, Sri Lanka and possibly with *alorensis* among the Lesser Sundas of Indonesia. It is possible that some of the previous records of *minutissimus* from several localities in India by Barraud (1924, 1934) are actually *infantulus*. Of all stages, the male genitalia of *infantulus* is most distinctive, particularly in the reticulate dorsal process of the phallosome.

Culex infantulus exhibits variations in all stages, but there is no indication that it is locally differentiated into any recognizable geographic forms among the material I have examined. The adults from Japan are larger and paler than those from Southeast Asia and the basal abdominal bands are variable from broad, narrow, complete to incomplete or sometimes absent, especially among the material from Peninsular Malaysia but all are remarkably constant in the details of the male genitalia. The pupa and larva of *infantulus* exhibit much overlap with *minutissimus* in most features of the chaetotaxy but can be separated from the latter by certain diagnostic features as indicated in the above description.

BIONOMICS. The pupa and larva of *infantulus* are most frequently found in small ground pools, including ditches, ponds, wells, footprints, tracks and occasionally in rock pools, natural or artificial containers, such as palm bracts, axils and earthenware jars and the margins of slow moving streams and creeks. The records from tree holes and bamboos in Thailand by Bram (1967a: 61) appear to be incorrect. They were probably based on erroneous field notes. The breeding sites are at a broad range of elevation and are usually under shade of tropical forests. The adults have been collected while resting on damp vegetation and stream banks and occasionally also from light traps. In a successful colonization of *infantulus* by Miyagi (1972) in Nagasaki, Japan,

the females were reported to readily feed on frogs, snakes, turtles as well as on chicks and mice. The development from larvae to emergence of imagos at room temperatures of 24-26°C lasts 9-11 days and the adults have a life span of 15 to 18 days (Miyagi 1973).

Fraudatrix Subgroup

The *Fraudatrix* Subgroup is characterized by the following characters: in the adults of both sexes by (1) abdominal terga usually entirely dark, sometimes with basolateral pale spots or with basal pale bands and (2) plume scales of wing veins R_2, R_3 relatively broad clavate or ovate; in the female by proboscis usually with 2 labial basal setae, sometimes 4-6; in the male by (1) palpal segment 1 with 2 distinct pairs of spiculose basal fingerlike processes; (2) proboscis usually with 2 prominent rows of upright sinuous setae on dorsal surface, sometimes reduced or absent; (3) labial false joint present, usually marked by flexion at 0.25 from extreme base and (4) modified tufts of setae and scales present on antennal flagellomeres 5-10 or 6-10; in the male genitalia by (1) subapical lobe of basimere usually with 2 leaflets (g_1, g_2), sometimes 1; (2) submarginal setae of basimere usually strongly differentiated, forming a distinct row on inner tergal surface, sometimes in a broad patch; (3) lateral plate of phallosome with a simple apical beaklike process (or dorsal process) on dorsal lobe (DL) and (4) proctiger crown small, with few to several spicules; in the pupa by (1) long, slender trumpet; (2) pinna of trumpet with slit extended to meatus; (3) setae 10, 11-C usually double; (4) seta 5-IV 3-7 branched and (5) setae 6-III-VI usually 2-4 branched; in the larva by (1) seta 4-C 0.25-1.00 times as long as distance between bases of the pair; (2) seta 3-P usually single or double, sometimes multiple; (3) seta 14-P usually single; occasionally double; (4) seta 7-I usually double, sometimes single and (5) seta 2-VIII double.

DISCUSSION. The *Fraudatrix* Subgroup as recognized here includes practically all species previously placed in the *Fraudatrix* Group in a strict or broad sense of Edwards (1932), Belkin (1962), Colless (1965) and Sirivanakarn (1968). The *Fraudatrix* Subgroup is the largest in the subgenus, comprising approximately 68 species: 20 in the Oriental region, 33 in the Australasian (Papua New Guinea and Australia); 12 in the South Pacific and 3 in Micronesia. All representatives of the *Fraudatrix* Subgroup in each respective area are basically similar in the comparatively simple male phallosome, but are slightly or strikingly differentiated from one another in the details of the male palpus, proboscis, modified tufts of antennal flagellomeres 5-8 and 9, submarginal setae of the basimere, setae of the subapical lobe, development of the apical dorsal beaklike process of the phallosome and the apical lobes of the paraproct of the proctiger. The relationships among the members of complexes of the *Fraudatrix* Subgroup are very close. However, there is apparently little or no overlap in species composition between the Oriental fauna and those from the Australiasian regions and the Pacific islands. There is also a strong indication of endemicity and independent development of the subgroup in each faunal area, which seems to further suggest that the speciation of the group probably occurred at the same time subsequent to the separation of the land masses. Most of the Oriental forms appear to be more primitive than those from the Australasian regions and the Pacific islands, but this can not be accurately determined until the entire fauna is more thoroughly known and compared in details with respect to their character states.

The *Fraudatrix* Subgroup is represented in the Oriental region by 7 complexes of 20 species. The characterization of the 7 complexes given below is limited to the most clearly marked and constant correlated features to indicate the diversity within the subgroup.

(1) *seniori* complex. The *seniori* complex includes only *seniori*. It is chiefly characterized in the male, the only known stage by: (1) the rudimentary basal fingerlike processes of the palpus; (2) the absence of dorsal upright setae on the proboscis; (3) modified tufts of the antenna poorly developed and are restricted only to flagellomeres 6-10; (4) leaflet g_1 and seta *h* of the subapical lobe absent or not developed; (5) submarginal of the basimere poorly differentiated; (6) apical dorsal beaklike process of the phallosome strong and moderately long; (7) paraproct with a single, short, rounded apical lobe adjacent to crown and (8) abdominal terga with basal pale bands.

(2) *cinctellus* complex. This complex includes the widespread *cinctellus* and the Philippine *fulleri*. It is characterized in the male by (1) well developed basal fingerlike processes of the palpus; (2) presence of dorsal upright setae on the proboscis; (3) modified tufts of the antenna well developed on flagellomeres 5-10; (4) F-5 with a small tuft of 2, 3 narrow or broad lanceolate scales, as long as the next 2 flagellomeres, followed by 2, 3 narrow, finely pointed scales of increasing length; (5) leaflet g_1 and seta *h* of the subapical lobe present; (6) submarginal setae of basimere numerous, in a broad patch; (7) apical dorsal beaklike process of the phallosome strong and moderately long; (8) apical lobe of paraproct poorly developed and (9) abdominal terga with basal pale bands; in the larva by (1) seta 5-C 3, 4 branched; (2) seta 4-P double and (3) seta 7-I double.

(3) *rubithoracis* complex. The *rubithoracis* complex is represented by *rubithoracis* which is common and very widespread throughout the Oriental region, the Malaysian *niger* and the Philippine *gibbulus*. This complex is differentiated from the *cinctellus* complex and the next 4 complexes below particularly in the following: the male by (1) dorsal upright setae of proboscis present or absent; (2) relatively short basal fingerlike processes of palpus; (3) F-5 with a small, inconspicuous tuft of 4, 5 short, narrow, linear, finely pointed scales or setae; (4) basimere with a row of 1-3 relatively weak submarginal setae; (5) all specialized setae and leaflets of subapical lobe well developed; (6) apical dorsal beaklike process of phallosome slender and moderately long; (7) paraproct of proctiger with well developed apical lobe or lobes and (8) abdominal terga without basal pale bands; the larva by (1) seta 5-C double or single; (2) seta 4-P double and (3) seta 7-I single.

(4) *inculus* complex. The *inculus* complex is represented by *inculus* which is a rare Southeast Asian form. It differs from *rubithoracis* and the next 3 complexes particularly in the following: the male by (1) dorsal upright setae of proboscis present; (2) basal fingerlike processes of palpus relatively long and distinct; (3) F-5 with a small, but distinct tuft of 8-10 dark, narrow, finely pointed scales; (4) basimere strongly swollen, with 1, 2 prominent rows of 10-12 strong submarginal setae; (5) leaflet g_1 and g_2 of subapical lobe very broad; (6) apical dorsal beaklike process of phallosome anvil-shaped, with several fine and sharp spicules on ventral surface and (7) paraproct without differentiated apical lobe; the larva by (1) seta 5-C single; (2) seta 4-P single and (3) seta 7-I single.

(5) *quadripalpis* complex. The *quadripalpis* complex comprises 6 species: *quadripalpis*, *aculeatus*, *paraculeatus*, *aestivus* and *reidi*. It is characterized by the following combination of characters: in the male by (1) dorsal upright setae of proboscis present; (2) basal fingerlike process of palpus relatively long

and very distinct; (3) F-5 with a distinct medium-sized tuft of 3-8 broad, blunt tipped or abruptly pointed scales and narrow fine-tipped scales as long as the next 3-4 flagellomeres; (4) basimere normal, usually with 3-7 weakly to strongly developed submarginal setae in a row, sometimes 1; (5) setae of subapical lobe well developed, leaflets g_1 and g_2 varied; (6) apical dorsal process of phallosome typically beaklike, length and thickness varied and (7) paraproct usually with well developed lateral and sternal apical lobes, shapes varied; in the larva by (1) seta 5-C double; (2) seta 4-P single and (3) seta 7-I double.

(6) *variatus* complex. The *variatus* complex is composed of 7 species: *variatus*, *josephinae*, *cubitatus*, *gracicornis*, *whartoni*, *macdonaldi* and *pairoji*. It is strongly characterized in the male by the large fan-shaped tuft of several broad scales on antennal flagellomere 5 and by the following additional features: (1) dorsal upright setae of proboscis present, well developed; (2) basal fingerlike processes of palpus varied, well developed; (3) basimere with a row of 3-7 strong submarginal setae; (4) all specialized setae of subapical lobe well developed, varied; (5) apical dorsal beaklike process of phallosome stout, length varied and (6) apical lobes of paraproct poorly or well developed; in the larva by (1) seta 5-C double or triple; (2) seta 4-P double and (3) seta 7-I double.

(7) *alphus* complex. The *alphus* complex is restricted to *alphus* which strongly resembles the members of the *variatus* complex in the modified tuft of male antennal flagellomere 5. It is chiefly characterized by the following: in the male by (1) basal fingerlike processes of palpus relatively long, reaching beyond apex of palpal segment 1; (2) modified tuft of antennal F-5 large, fan-shaped, composed of several broad scales; 3-6 scales in lateral ventral group with characteristic swelling in distal subapical portion; (3) apical dorsal beaklike process of phallosome very short and slender and (4) paraproct of proctiger with a small apical sternal lobe only; in the larva by (1) seta 5-C double, reduced in length, about 0.5-0.75 of 6-C; (2) seta 4-P double; (3) seta 7-I single; (4) comb scales strongly differentiated in length and size, those in the posterior row elongate, 2, 3 times as long as the anterior ones and (5) pecten teeth simple or with a weak fringe of numerous minute denticles.

seniori complex

4. *CULEX (LOPHOCERAOMYIA) SENIORI* BARRAUD
(Fig. 6)

Culex (Lophoceratomyia) seniori Barraud 1934: 365 (♂*).
Culex (Lophoceraomyia) seniori Barraud; Stone, Knight and Starcke 1959: 235 (catalog).

FEMALE. Unknown.

MALE (Fig. 6). Based on the holotype (wing length 2.8 mm). *Palpus*. Slender, long, exceeding proboscis by 0.5 of the length of segment 5; segment 1 with 2 pairs of very short, tiny, subequal basal fingerlike processes which are about 0.5 of distal portion of segment 1; apical 0.1 of segment 3 with ventrolateral tuft of 4, 5 bristles; segments 4 and 5 moderately plumose. *Proboscis*. Dorsal upright setae on labium absent or not developed; labial basal setae 10, all of which are short, subequal, stout, spinelike, in a transverse row on ventral surface; false joint not clearly marked. *Antenna*. Pedicel

simple, rounded; flagellar whorls densely long plumose; modified tufts of scales and setae present only on F-6 to F-10; F-6 with a small mesal tuft of 4-5 dark, thickened, more or less fused setae, as long as the length of 1 flagellomere; F-7 with a rudimentary ventral tuft of 3 dark, short, flattened, apically blunt setae and a small mesal tuft of 3, 4 longer hairlike setae; F-8 with a large, prominent mesal tuft of 5 dark, fused bristlelike setae, as long as the next 3 flagellomeres; F-9 with a mesal tuft of 2 dark, long bristlelike and 2, 3 hairlike setae, as long as the next 5, 6 flagellomeres; F-10 with similar tuft of setae as on F-9. *Thorax*. Integument of mesonotum and pleuron light brown; mesonotal scales dark, narrow, moderately dense; pleuron without distinct scale patch, a few scales present on upper corner of *stp; ppl* bristles 4; 1 lower *mep* bristle present. *Legs*. Anterior surface of fore- and midfemora dark; anterior surface of hindfemur with longitudinal pale stripe from base to near apex; tibiae and tarsi of all legs dark. *Wing*. Scales on all wing veins dark and rather scanty; scales on veins R_2, R_3 and R_{4+5} small, broad clavate. *Abdomen*. Terga I, II entirely dark; terga III-VII with basal transverse pale bands; sterna entirely pale beige or yellowish.

MALE GENITALIA (Fig. 6). As figured and as in the following description. *Basimere*. Conical; tergomesal margin lightly convex; inner tergal surface with several strong setae, which are widely scattered, not forming a row along tergomesal margin. *Subapical Lobe*. Rodlike setae *a-c* of proximal part subequal and straight, setae *a* and *c* apically hooked, seta *b* tapered into a point; distal part with 5 bladelike setae in group *d-f*, most distal seta (= leaflet g_2) longest, lanceolate, the rest shorter and narrower; leaflets g_1 and seta *h* absent. *Distimere*. Normal, without subapical crest of spicules; subapical claw moderately long; 1 tiny ventral seta present distad of middle curvature, dorsal seta absent. *Phallosome*. Apical dorsal lobe of lateral plate represented by a stout, short, beaklike process, sustaining about 90 degrees with the main stem; ventral lobe well developed and rounded on sternal margin. *Proctiger*. Apical crown relatively small, composed of dark, short, spinelike spicules only; paraproct well sclerotized, broad, with a distinct apical lobe; cercal sclerite well sclerotized; cercal setae 2.

PUPA and LARVA. Unknown.

TYPE-DATA. Holotype ♂* with slide of genitalia, palpus, proboscis and antenna; Garden Reach, *Calcutta*, INDIA, October 1931, R. Senior-White (BMNH).

DISTRIBUTION. Known only from the type-locality. 1 specimen examined: ♂ (marked as type), as indicated in the type-data.

TAXONOMIC DISCUSSION. *Culex seniori* is known only from the single type male originally described and figured by Barraud (1934: 365). It is essentially similar to all members of the *Fraudatrix* Subgroup in the development of the basal processes of the palpus, the spinelike labial basal setae of the proboscis and in the type of phallosome of the genitalia but can be readily recognized by (1) presence of basal pale bands on the abdominal terga; (2) absence of dorsal upright setae on the proboscis; (3) characteristic modified tufts of setae on antennal flagellomeres 6-10 and (4) details of setae of the subapical lobe of the genitalia as indicated in the key and as described above. Because of several distinctive features of the male, *seniori* is here placed in its own complex separated from the other complexes of the *Fraudatrix* Subgroup.

BIONOMICS. The male of *seniori* apparently came from a general field catch. No further data are available.

cinctellus complex

5. *CULEX (LOPHOCERAOMYIA) CINCTELLUS* EDWARDS
(Figs. 4, 5)

Culex (Lophoceratomyia) cinctellus Edwards 1922a: 287 (new name for *Lophoceratomyia taeniata* Leicester 1908, nec Wiedemann; ♂*, key); Barraud 1924: 42 (♂*); Edwards 1932: 197 (taxonomy); Barraud 1934: 366 (♂*, ♀, L); Brug and Bonne-Wepster 1947: 186 (distribution); Chu 1958: 110 (distribution).

Culex (Lophoceraomyia) cinctellus Edwards, Stone, Knight and Starcke 1959: 232 (catalog); Colless 1965: 277 (♂*, ♀, L*); Delfinado 1966: 103 (♂*); Bram 1967a: 55 (♂*, ♀, L*).

FEMALE. Wing: 3.0 mm. Forefemur: 1.44 mm. Proboscis: 1.85 mm. Abdomen: 2.2 mm. Medium-sized species, distinguished from all members of the *Fraudatrix* Subgroup except *seniori* by the presence of basal pale bands on the abdominal terga and by the following features. *Head*. Decumbent scales of vertex largely broad, pale anteriorly, forming a distinct ocular line, darker posteriorly; narrow decumbent scales restricted to occiput and dorsal midline (coronal suture) of vertex; lateral patch of broad scales whitish, distinct. Palpus varying from 0.15-0.20 of proboscis length. Proboscis with 2 labial basal setae which are dark, hairlike, about 0.5 of palpal length. *Cibarial Armature* (Fig. 4). Cibarial bar concave, with 60 or more teeth in close-set row, all of which are narrow, fine, more or less pointed, subequal in size and length. *Thorax*. Mesonotal integument light to dark brown; scales narrow, dark brown. *Ppn* with some scattered dark scales and tiny setae cephalad of 3,4 posterior bristles. Pleuron same color as mesonotum or slightly paler; upper corner of *stp* with or without a few pale scales; *ppl* bristles 4-6; upper *mep* setae 7; 1 lower *mep* bristle present. *Legs*. As in *seniori*, without any marked coloration; anterior surface of hindfemur with longitudinal pale stripe in basal 0.5, apical 0.5 dark scaled. *Wing*. Plume scales on veins R_2, R_3 and R_{4+5} moderately broad, clavate. *Abdomen*. Tergum II with narrow basal pale bands, not completely extended laterad; terga III-VII with complete basal pale bands; sterna entirely pale.

MALE (Fig. 4). In general conforms to the *Fraudatrix* Subgroup, with the following distinctive characters. *Palpus*. Exceeding proboscis by a little more than the full length of segment 5; basal fingerlike processes short, less than 0.5 of the length of distal portion of segment 1; segment 3 with 4-10 ventrolateral bristles in apical 0.1-0.2, ventral surface with 1,2 fine, short, hairlike setae; segments 4, 5 upturned and strongly plumose. *Proboscis*. Apical 0.5 or more of labium with a double row of fine, upright, sinuous setae on dorsal surface, longest setae about 3 times as long as labial width; labial basal setae short, stout, spinelike, 12 in number; false joint present at 0.20-0.25 of the length from base. *Antenna*. Flagellar whorls densely long plumose, modified tufts of scales and setae well developed on lateral basal tubercles of long normal setae of flagellomeres 5 to 10; F-5 with a small dorsolateral tuft of 2,3 broad, lanceolate or abruptly pointed scales which are as long as the next 2 flagellomeres, followed by 2,3 narrower, fine-tipped scales of increasing length; F-6 with a dark crumpled tuft of several heavily curled setae on lateral ventral surface; F-7 with a lateral tuft of about 10 curled, apically twisted setae in row resembling the shape of a comb and a ventral mesal tuft

of 3, 4 stout, proximally fused, curled setae; F-8 with a ventral slender tuft of 6-8 fused setae in form of a J-hook; F-9 with a ventral tuft of 4, 5 long, distally broad, bladelike scales and several short, hairlike setae; F-10 with a ventral tuft of 2, 3 dark, long, distally curved bristlelike setae.

MALE GENITALIA (Fig. 4). *Segment IX.* Tergal lobe very small, bearing a row of 2 or 3 short setae; sternum broad, usually entirely bare or sometimes with 1 strong seta on median caudal margin. *Basimere.* Very stout, conical, about 0.2 mm in length; basal 0.5 lightly to strongly swollen; inner tergal surface with 15 or more strong submarginal and marginal setae aggregating into a patch along tergomesal margin, 4, 5 lateral setae are longest and strongest, the rest shorter and weaker; setae on outer tergal area laterad of submarginal setae and subapical lobe sparse. *Subapical Lobe.* Prominent; rodlike setae *a-c* of proximal part very stout and gently curved in middle; distal part with setae in group *d-f* strong, bladelike, 5, 6 in number, seta g_2 strongly differentiated from setae *d-f* as a broad, lanceolate leaflet; leaflet g_1 very broad, with acuminate apex, seta *h* strong. *Distimere.* Thick, more or less straight from base to 0.75 of total length; apical 0.25 weakly curved, lightly to strongly swollen on ventral surface; subapical claw well developed; ventral subapical seta very strong, 2, 3 times as long as dorsal subapical seta. *Phallosome.* Apical dorsal beaklike process of lateral plate strong and moderately long, apical margin smooth. *Proctiger.* Apical crown medium-sized, with several dark spinelike spicules; paraproct strongly sclerotized, moderately to strongly pigmented, apical lobe not developed; cercal sclerite moderately to strongly pigmented; cercal setae usually 2, sometimes 3.

PUPA (Fig. 4). Abdomen: 2.5 mm. Paddle: 0.7 mm. Trumpet: 0.65-0.70 mm; index 10. Chaetotaxy as figured, distinctive in the following. *Cephalothorax.* Seta 1-C double; 8-C single; 9-C 3, 4 branched. *Metanotum.* Seta 10-C 3, 4 branched. *Abdomen.* Seta 6-III-VI single or double; 5-IV 4, 5 branched; 5-V 2-4 branched; 5-VI usually double (1-3); 9-VII double or triple; 4-VIII usually double (2-3); 9-VIII usually 5 branched (4-6). *Paddle.* Midrib moderately to strongly pigmented.

LARVA (Fig. 5). Head: 0.7 mm. Siphon: 1.8 mm; index 9. Saddle: 0.35 mm; siphon/saddle ratio 4. General features and chaetotaxy as figured, the following are diagnostic. *Head.* Seta 4-C distally forked into 3, 4 branches, its length about 0.5 of the distance between bases of the pairs; 5-C 3, 4 branched; 6-C double. *Thorax.* Spiculation not developed; seta 3-P usually double, sometimes single or triple; 4-P double. *Abdomen.* Unspiculated; seta 7-I double; 1-III-VI usually 4 branched (3-5); 6-III-VI usually 4 branched (4-5). Saddle lightly spiculated on posterior caudal margin; seta 2-X usually 4 branched; anal gills as long as or longer than saddle. *Siphon.* Very slender, same color as head capsule, without median dark ring; pecten teeth 10-11, most distal tooth with 12, 13 fine denticles; subventral tufts very weak and rather inconspicuous, 4 pairs, all of which are double, subequal, shorter or as long as siphonal width at points of attachment; 2-S very weak and short; median caudal filament of spiracular apparatus well developed.

TYPE-DATA. Lectotype ♂* (originally marked as a cotype of *Lophoceratomyia taeniata* Leicester 1908) with attached genitalia mount, marshy ground, Circular Road, Kuala Lumpur, *(Selangor), Malaya* [MALAYSIA], December 10, 1903, G. F. Leicester (BMNH; selection of Colless 1965: 278).

DISTRIBUTION. Widespread throughout Southeast Asia, also reported from India. 140 specimens examined: 104♂, 25♀, 11 L, 9 with associated immature skins (4 p, 5 lp).

INDIA. *Assam:* Rupsi; Dibrugarh; 2♂.

THAILAND. *Khon Kaen:* Chumphae; Pa Dong Lan; *Chon Buri:* Siracha, Bang Phra; Bang La Mung; Khao Mai Kaeo; *Nakhon Si Thammarat:* Choung Khao; *Narathiwat:* Ban Kado; 12♂, 1 L, 2 p, 1 lp.

VIETNAM. Danang; Ankhe; Lai Khe; 2♀, 1 L.

MALAYSIA. *Peninsular Malaysia - Selangor:* Kuala Lumpur, Circular Road; Pacific Tin; Kuang; *Pahang:* Cameron Highlands, Mt. Brinchang; Bentong Road; *Perak:* Strait Settlements; Kedah; Pusing; Kuala Kangsar; *Johore:* Kota Tinggi; *Malaysia - Sarawak,* Kuching; *Sabah:* Kota Kinabalu Tawau; 33♂, 21♀, 10 L; 2 p, 4 lp.

SINGAPORE. 3♂, 2♀.

INDONESIA. *Java:* Djakarta; Kebon Ros; Belakang Ponrok; Surabaja, Bengkulu; 5♂.

PHILIPPINES. *Luzon; Samar:* San Antonio; *Leyte:* Palo; Dulag; Tacloban, Diit River, Burugwin; 49♂.

Additional records from the literature. CHINA: Hainan Island (Chu 1958); INDONESIA: Sumatra (Brug and Bonne-Wepster 1947); INDIA: Malabar Coast, Pudupadi (Barraud 1934): JAPAN: Ryukyus, Yaeyama (Bohart 1959).

TAXONOMIC DISCUSSION. The adults of *cinctellus* can be readily recognized by the presence of basal pale bands on the abdominal terga and by the features of the palpus, proboscis and the modified tufts of the antenna of the male as indicated in the keys and in the above description. The *cinctellus* female may be confused with those of *infantulus*, *minutissimus*, *alorensis* and *seniori* which exhibit similar abdominal tergal pale bands. It can, however, be separated from these species by the relatively larger size, the broader plume scales on wing veins R_2, R_3 and R_{4+5}; the presence of only 2 labial basal setae of the proboscis and by having pale decumbent scales of vertex of the head forming a very distinct ocular line. The male genitalia are most diagnostic in the shape of the basimere, the aggregation of several strong submarginal setae into a broad patch on the inner tergal surface of the basimere and in the development of the setae of the subapical lobe. The pupa can be readily recognized by the single seta 8-C; the larva by the 3, 4 branched seta 5-C and by several combinations of characters as given above.

Culex cinctellus is closely related to *fulleri* Ludlow from Mindanao, the Philippines, on the basis of the male genitalia and with the latter apparently falls into a distinct complex of the *Fraudatrix* Subgroup. Both species resemble *seniori* more than any other in the shape of the basimere and apical dorsal process of the phallosome of the male genitalia.

BIONOMICS. The immatures of *cinctellus* have frequently been collected in large bodies of water on the ground such as marshy depressions, swamps, ditches and stream margins under partial or heavy shade of forests. On occasion, they have also been collected from small ground pools. The elevation ranges from above sea level to 1,000 m. The adults were collected by light traps, animal bait traps and sweep nets while resting or biting. In Malaysia, they were commonly taken while resting among vegetation in forests or more open areas but were rarely taken with mammalian bait (Colless 1965: 278). The females are probably largely bird feeders (Colless 1959) but they were also reported to bite and feed on man in the forest canopy (Macdonald and Traub 1960).

6. *CULEX (LOPHOCERAOMYIA) FULLERI* (LUDLOW)
(Fig. 6)

Oculiomyia fulleri Ludlow 1909: 97 (♀).
Culex (Lophoceratomyia) fulleri (Ludlow), Edwards 1922a: 287 (♂*, key); Edwards 1932: 197 (taxonomy).
Culex (Lophoceraomyia) fulleri (Ludlow), Bohart 1945: 74 (♂*); Stone and Knight 1957: 50 (lectotype designation); Stone, Knight and Starcke 1959: 233 (catalog); Delfinado 1966: 104 (♂, ♀).

FEMALE. Wing: 3.4 mm. Forefemur: 1.6 mm. Proboscis: 2.0 mm. As described for *cinctellus*, differing from it in the absence of basal pale band on abdominal terga and in the following characters. *Head*. Broad decumbent scales of vertex largely pale. *Cibarial Armature*. Cibarial teeth apparently finer and more numerous, about 80 in number. *Thorax*. *Ppl* bristles 6, 7. *Abdomen*. Terga entirely dark dorsally, terga III-VII with small basolateral pale spots.

MALE (Fig. 6). Differing from *cinctellus* as described for the female and in the following additional features. *Palpus*. Fine hairlike setae on ventral surface of palpal segment 3 more numerous and rather denser. *Antenna*. Modified tuft of F-5 with 4, 5 narrower, fine tipped scales; F-9 with 5, 6 darker and broader bladelike scales; F-10 with 3, 4 stronger, more flattened bristlelike setae.

MALE GENITALIA (Fig. 6). As figured; exceedingly similar to *cinctellus*, differing constantly in the following details. *Basimere*. Larger, about 0.25 mm in length; basal portion strongly swollen; submarginal setae stronger, densely packed, 4 or 5 of which are longest, 5 times as long as shorter submarginals. *Subapical Lobe*. Leaflets g_1 and g_2 broadly foliate in apical portion; setae *d-f* shorter and narrower. *Distimere*. Thicker and longer, strongly swollen beyond middle before tapering to a blunt point apically; subapical portion strongly annulated; subapical claw shorter. *Proctiger*. Paraproct with well developed apical sternal lobe sternad of crown of spicules; cercal setae 4 in number.

PUPA and LARVA. Unknown.

TYPE-DATA. Lectotype: ♀*, Parang (Cotabato), *Mindanao*, PHILIPPINES, October 25, 1908, Major Fuller (USNM; selection of Stone and Knight 1957: 50).

DISTRIBUTION. Known only from Mindanao and Jolo Jolo islands in the Philippines. 137 specimens examined: 77♂, 60♀.

PHILIPPINES. *Mindanao:* Parang, Ludlow Barracks; Kabakan; Agusan S. Francisco; 75♂, 60♀; *Jolo Jolo* Is.; 2♂.

TAXONOMIC DISCUSSION. The Philippines records of *fulleri* from Leyte and Luzon by Bohart (1945) and Delfinado (1966) are doubtful and need to be confirmed since I have not seen any specimens from these areas. It is possible that these records were based on the misidentified specimens of *cinctellus* which is widespread in those islands.

Culex fulleri exhibits constant differences from *cinctellus* in several details of the male genitalia and in the absence of the basal pale bands on the abdominal terga but is basically similar to the latter in the characters of the male antenna, palpus, proboscis and in the shape of the basimere and the phallosome. It also appears to be geographically isolated from *cinctellus*, suggesting that it may be only subspecifically distinct.

BIONOMICS. The breeding site of *fulleri* is not known but is most probably

the ground pool habitat as in *cinctellus*. All of the adults apparently came from general field catches by net and light traps. Nothing is known about the adult feeding behavior and its medical importance.

rubithoracis complex

7. *CULEX (LOPHOCERAOMYIA) RUBITHORACIS* (LEICESTER)
(Figs. 7, 8)

Lophoceratomyia rubithoracis Leicester 1908: 119 (♂, ♀).
Culex (Lophoceratomyia) rubithoracis (Leicester), Edwards 1932: 197 (taxonomy); Barraud 1934: 367 (♂*, ♀); Hsiao and Bohart 1946: 25 (distribution); Bohart 1946: 16 (key); LaCasse and Yamaguti 1950: 192 (♂*, ♀*, P*, L*); Hara 1957: 57 (♀ genitalia*).
Culex (Lophoceraomyia) rubithoracis (Leicester), Mattingly 1949: 224 (L*, key); Stone, Knight and Starcke 1959: 235 (catalog); Colless 1959: 114 (L); Lien 1962: 632 (distribution, biology); Colless 1965: 281 (♂*, ♀, L*); Delfinado 1966: 113 (♂); Bram 1967a: 69 (♂*, ♀, L*).

FEMALE. Wing: 2.1-2.7 mm (average 2.2 mm). Forefemur: 1.0 mm. Proboscis: 1.4 mm. Small, yellowish brown species; in general as described for the *Fraudatrix* Group and Subgroup with the following diagnostic features. *Head*. Decumbent scales of vertex broad, pale along upper eye margin, forming distinct ocular line, dark posteriorly; narrow, linear decumbent scales relatively few in number, restricted to coronal suture and occiput; erect scales short, dark and rather sparse; lateral patch of broad scales pale beige or yellowish white. Palpus very slender, 0.2 of proboscis length. Proboscis with 2 labial basal setae, nearly as long as palpal length. *Cibarial Armature* (Fig. 7). As figured, cibarial bar relatively short, with about 30 teeth in concave row; median 4-6 weak, short, lateral teeth stronger, flattened and apically blunt. *Thorax*. Mesonotal integument with characteristic hue of bright yellow, orange or sometimes reddish brown, but not dark brown or chestnut brown; scales on mesonotal disc narrow, linear, dark brown, sparse or moderately dense. *Ppn* with some scattered, semi-erect narrow scales cephalad of 2-4 strong posterior bristles. Pleural integument same color as mesonotum; scales on upper corner of *stp* practically absent; *ppl* bristles few, 1 or 2 of which are strong and dark; lower *mep* bristle absent. *Legs*. Without any marked coloration. *Wing*. Scales on all veins rather scanty; plume scales on veins R_2, R_3 and R_{4+5} narrow, linear in basal portion, broader in apical portion. *Abdomen*. Terga entirely dark, basolateral pale spots absent; terga V-VII usually with narrow lateral pale stripe; sterna whitish or yellowish.

MALE (Fig. 7). In general similar to female, with the following diagnostic features. *Palpus*. Very slender and thin, longer than proboscis by 0.5-1.0 of segment 5; basal fingerlike process of segment 1 minute, short, rather inconspicuous; basal 0.5 of segment 2 with a row of dark, short, spinelike setae; ventral surface of segment 3 with a row of fine, minute setae which are dense in basal 0.5, sparse in apical 0.5, its apical 0.25 with a ventrolateral tuft of 5, 6 dark bristles; segments 4 and 5 moderately to strongly plumose. *Proboscis*. Slender; ventral surface slightly paler than dorsal surface; distal 0.5 of labium with distinct double rows of dorsal sinuous setae which are 2 or 3 times as long as labial width; labial basal setae dark, stout, spiniform, 10 in number. *Antenna*. Flagellar whorls densely long plu-

mose; modified tufts well developed on F-5 to F-10; F-5 with a small tuft of 2-5 very narrow, finely pointed scales which are pale yellowish to blackish, subequally long, as long as the combined length of the next 3 flagellomeres; F-6, 7 with dark crumpled tufts of heavily curled setae as described for the group; J-hook tuft of F-8 very slender, composed of 6, 7 fused setae; F-9 with 5 dark, very broad, bladelike scales; F-10 with 2, 3 dark long bristlelike setae.

MALE GENITALIA (Fig. 7). As described and figured by Colless (1965: 281-2). *Segment IX.* Tergal lobe very small, bearing 2, 3 weak and short setae. *Basimere.* Normal, small, slender, 0.17 mm in length; inner tergal surface with 3 strong submarginal setae in a row parallel to tergomesal margin; marginal setae 6, 7 widely spaced, 2, 3 basal ones strongest; strong bristles largely confined to lateral tergal areas. *Subapical Lobe.* Rodlike setae *a-c* of proximal part stout, subequal, lightly curved in distal portion; leaflets g_1, g_2 and seta *h* of distal part well developed; leaflet g_1 club-shaped; setae *d-f* 5, 6, all flattened, bladelike, 2, 3 of which are strongly bent in middle. *Distimere.* Slender, lightly or strongly curved distad of midpoint; subapical claw small, short, apically dilated and rounded; 1 ventral and 1 dorsal tiny seta present near apex. *Phallosome.* Apical dorsal beaklike process of lateral plate short and relatively slender. *Proctiger.* Apical crown very small, or poorly developed, consisting of only a few pale or dark spinelike spicules; apex of paraproct with a characteristic budlike apical lobe; lateral paraproct and cercal sclerite well sclerotized; cercal setae 2.

PUPA (Fig. 7). Abdomen: 2.0 mm. Paddle: 0.52 mm. Trumpet: 0.65 mm; index 11-12. Cephalothorax yellowish, with or without brownish areas on apex of head shield, posterior mid-dorsal ridge, leg, wing and labial cases. Trumpet darker than underlying integument. Chaetotaxy as figured, the following combination of seta branching is diagnostic. *Cephalothorax.* Seta 1-C usually triple (3-4); 3-C usually double (2-3); 8, 9-C double. *Metanotum.* Setae 10, 11-C double. *Abdomen.* Seta 6-III, IV usually triple (2-4); 6-V, VI usually 4 branched (3-4); 5-IV 6-8 branched; 5-V usually 4 branched (3-6); 5-VI double or triple, rarely single; 9-VII double or triple; 4-VIII double or triple; 9-VIII 4-6 branched. *Paddle.* Basal external margin of outer part usually with characteristic infuscated area; midrib weak and pale with characteristic dark spot towards apex; setae 1, 2-P present, minute.

LARVA (Fig. 8). Head: 0.6 mm. Siphon: 1.0-1.4 mm; index 9. Saddle: 0.28-0.30 mm; siphon/saddle ratio 4. As characterized for the group and complex; chaetotaxy as figured; the following are diagnostic. *Head.* Seta 13-C 3, 4 branched; 16, 17-C very well developed and distinct. *Thorax.* Spiculation light to moderate, usually visible under 10X objective; seta 3-P usually 4 or more branched (2-11); 4-P double. *Abdomen.* Unspiculated; seta 7-I always single; 1-III-VI 4, 5 branched; 6-III-VI usually 4, 5 branched (4-6). Comb scales numerous (40-50), all similar in size and with even apical fringe of fine spicules. Saddle same color as siphon; seta 2-X with 3 short and 1 long branched; ventral brush (4-X) with 5 pairs of setae; anal gills 1.5 times as long as saddle. *Siphon.* Slender, thin, moderately long and uniformly yellowish distally; pecten teeth 10, each barbed with 10-12 fine denticles; subventral tufts 4 pairs (total 8), all subequal, very weak, short, double or triple each; slightly longer than siphonal width at points of attachment; 2-S very short and weak; median caudal filament of spiracular apparatus very well developed.

TYPE-DATA. Lectotype ♂* with attached genitalia mount, Circular Road, Kuala Lumpur, [*Selangor*], *Malaya* [MALAYSIA], marsh, November 6, 1903, G. F. Leicester (BMNH; selection of Colless 1965: 281).

DISTRIBUTION. Widespread throughout the Oriental region; also reported

from Japan. 413 specimens examined: 360♂, 42♀, 14 L; 28 with associated immature skins (11 pupal, 17 larval).

INDIA. *Assam:* Dibrugarh; Bengal: Lalmanirhat; 2♂.

BURMA. *Rangoon;* 2♂, 3♀.

SRI LANKA. *Western Province:* Colombo District, Waga; 2♀.

THAILAND. *Chiang Mai:* Muang; San Pha Thang, Ban San Khayom; Mae Rim; Ban Chang Kien; *Udon Thani:* Muang, Ban Nong Bua; *Khon Kaen; Nontha-buri:* Pak Kret; *Bangkok;* Phaket: Ban Borae; Ban Pha Thong; 389♂, 4♀, 5 L; 9 p, 1 lp.

CAMBODIA. *Phnom Penh*; 4♂, 1♂ genitalia.

VIETNAM. Con Son; Phu Lai; Vung Tau; Cam Ranh; 4♂, ♀, 3 L.

MALAYSIA. *Peninsular Malaysia - Johore:* Kg. Kahang; *Trengganu:* Kuala Brang; *Pahang:* Pdg. Tungku; *Perak:* Pusing; Chior; Tg. Rambutan; 13♂, 25♀, 5 L; 2 p, 7 lp.

SINGAPORE. 4♂, 3♀.

INDONESIA. *Java:* Djakarta; ♀♂; *Sumatra:* Dermajo; 1♂; *Celebes;* 2♂.

PHILIPPINES. *Luzon:* Subic Naval Base; *Mindoro:* San Jose; *Leyte:* Tacloban; Palo; *Sulu Archipelago (Mindanao): Jolo Is.*; 25♂, 4♀, 9 lp.

HONG KONG. 1♂.

JAPAN. *Honshu:* Kyoto; 1♂, 1 L.

Additional records from the literature. MALAYSIA and INDONESIA: Borneo (Brug and Bonne-Wepster 1947: 186); CHINA: Chekiang; Kwangtung (Feng 1938: 299); TAIWAN (Lien 1962: 632).

TAXONOMIC DISCUSSION. The adults of *rubithoracis* can be readily recognized by the small size, the orange or bright yellow integument of the thorax and by the absence of the lower mesepimeral bristle. Males can be recognized by the small modified tuft of 2-5 narrow, finely pointed scales of antennal flagellomere 5 and the dark, subapically bladelike scales of antennal flagellomere 9. The male genitalia are very diagnostic, particularly in the presence of a row of 3 submarginal setae on the inner tergal surface of the basimere; the small proctiger crown and in the characteristic budlike apical lobe of the paraproct. In the immature stages, the pupa is readily recognized by the dark spot on the apex of the paddle midrib and the larva by the multi-branched seta 3-P, the single branched seta 7-I and by having only 5 pairs of setae in the ventral brush (4-X) of the saddle.

Culex rubithoracis is one of the most common species in the subgenus and is apparently as widespread as *infantulus*. All stages of *rubithoracis* are variable, but there is no indication of geographic differentiation among the material I have examined. It is evidently closely related to *niger* and *gibbulus* on the basis of the male characters as well as the immature stages. Together with these 2 species it falls into a distinct complex of the *Fraudatrix* Subgroup. The members of the *rubithoracis* complex also appear to be related to the New Guinea *pseudorubithoracis* complex of Sirivanakarn (1968: 178-80); however, their true affinity can be definitely determined only when the immature stages of the New Guinea forms are known.

BIONOMICS. The immatures of *rubithoracis* are most frequently found in open, sunlit habitats such as ricefields and marshy depressions, quite different from most forms of the *Fraudatrix* Group which usually breed in heavily or partially shaded ground pool habitats in forests. The breeding sites of *rubithoracis* are in most cases, small ground pools, puddles and ditches with emergent or submerged aquatic vegetation such as grasses, duckweed and lily

pads in the flat swampy ground just above sea level. The numerous adults collected in Thailand came from light traps. Nothing is known about adult feeding preferences and the medical importance.

8. *CULEX (LOPHOCERAOMYIA) NIGER* (LEICESTER)
(Figs. 9, 10)

Lophoceratomyia niger Leicester 1908: 123 (♂, ♀).
Culex (Lophoceratomyia) atratulus Edwards 1922a: 287 (new name for *niger* Leicester 1908, in error).
Culex (Lophoceratomyia) niger (Leicester), Edwards 1932: 197 (taxonomy).
Culex (Lophoceraomyia) niger (Leicester), Stone, Knight and Starcke 1959: 235 (catalog); Colless 1965: 282 (♂*, ♀, L*).

FEMALE. Wing: 2.7 mm. Forefemur: 1.3 mm. Proboscis: 1.9 mm. Small, blackish species with the following distinctive features. *Head*. Broad decumbent scales on upper eye margin and posterolateral area of vertex blackish; narrow decumbent scales pale, shiny brown, numerous, occupying a broad area in center and on occiput; lateral patch of broad scales predominently dark except for a few bluish white ones along eye margin. Palpus rather short, about 0.17 of proboscis length. Proboscis with 2 labial basal setae which are moderately long, about 0.5 of palpal length. *Ciberial Armature:* Not studied. *Thorax*. Integument of mesonotum dark brown to almost black; mesonotal scales blackish; dorsocentral and scutellar bristles very strong and dark. *Ppn* with a few dark scalelike setae cephalad of 4 posterior bristles. Pleuron as dark as mesonotum in upper 0.5, slightly paler in lower 0.5; *ppl* with 4 bristles and 3, 4 other short and weak setae; 1 lower *mep* bristle present; lower posterior portion of *mep* with a minute patch of about 5 semi-erect scalelike setae. *Legs*. Anterior surface of hindfemur with a silvery white longitudinal stripe extending from base to near apex. *Wing*. Scales in apical portion of veins R_2 and R_3 moderately broad clavate. *Abdomen*. Terga entirely dark or black; terga III-VII with basolateral pale spots; sterna pale yellowish.

MALE (Fig. 9). As described for the female except for the absence of basolateral pale spots on the abdominal terga, differing from other members of *rubithoracis* complex in the following characters. *Palpus*. Longer than proboscis by the full length of segment 5; basal fingerlike process of segment 1 distinct, moderately long, about 0.5 of the distal part of the segment; segment 3 with 1 ventrolateral bristle subapically; segments 4 and 5 weakly plumose, with several weak and short bristles. *Proboscis*. Dorsal upright setae absent. *Antenna*. Flagellar whorls strongly plumose; F-5 with a small tuft of 4-6 dark, narrow, finely pointed scales which are subequally long, as long as the combined length of the next 4 flagellomeres; F-6 to F-8 with similar modified tufts of setae as in *rubithoracis;* F-9 with 2, 3 bladelike scales; F-10 with 2 long bristlelike setae.

MALE GENITALIA (Fig. 9). Exceedingly similar to *rubithoracis*, differing from it particularly in the following features. *Segment IX*. Sternum with 1 strong seta towards caudal margin. *Basimere*. Inner tergal surface with 1 or sometimes 2 other weak submarginal setae in a row; median tergal area laterad of subapical lobe without any setae. *Subapical Lobe*. Bases of rodlike seta *a-c* of proximal part with a group of 4, 5 apically hooked fine setae on mesal surface; setae in group *d-f* 5, all of which are flattened, bladelike; leaflets g_1, g_2 broad foliate and apically acuminate, leaflet g_1 apparently shorter and

smaller than leaflet g_2. *Phallosome*. Apical dorsal beaklike process of lateral plate very slender, long, with apex terminated into a sharp, curved point. *Proctiger*. Crown small, consisting of about 10 spinelike spicules aggregating into a tuft on mesal surface; apex of paraproct very characteristic, with a long, slender thumblike external lobe and a broad, apically rounded sternal lobe; cercal setae 2, 3.

PUPA (Fig. 9). Based on 1 associated skin. Abdomen: 2.2 mm. Paddle: 0.65 mm. Trumpet: 0.65 mm; index 10. Essentially similar to *rubithoracis* in the detailed chaetotaxy, differing from it particularly in the following. *Cephalothorax* and *Metanotum*. Entirely brownish. *Trumpet*. Slender, long, as dark as underlying integument. *Abdomen*. Segments I-V brownish or same color as cephalothorax; segments VI-VII slightly paler. *Paddle*. Midrib strong and dark pigmented; areas surrounding midrib strongly infuscate; basal external margin of outer part pale or not infuscate.

LARVA (Fig. 10). Based on 1 associated skin. Head: 0.65 mm. Siphon: 1.3 mm; index 7. As figured, differing from *rubithoracis* in the following characters. *Head*. Seta 5-C single; 7-C very dark, with 10 flattened, strongly plumose branches. *Thorax*. Spiculation absent or not developed; seta 3-P double. *Abdomen*. Seta 7-I double. *Siphon*. Subventral tufts stronger and longer, 5 pairs, each 3, 4 branched, 1.5-2.0 times as long as siphonal width at points of attachment.

TYPE-DATA. Lectotype ♂* with slide of antenna, palpus, proboscis and genitalia, Circular Road, Kuala Lumpur, [*Selangor*], *Malaya* [MALAYSIA], October 7, 1903, G. F. Leicester (BMNH; selection of Colless 1965: 282).

DISTRIBUTION. Known only from Selangor, Malaysia. 6 specimens examined: 3♂, 3♀, 1 with associated lp skins.

MALAYSIA. *Peninsular Malaysia*. *Selangor:* Kuala Lumpur; 1♂ (holotype), 1♀ (cotype); Puchong Rd.; 2♂, 2♀, 1 lp.

TAXONOMIC DISCUSSION. *Culex niger* is a rare Malaysian species. It exhibits a stronger affinity with *rubithoracis* than with any other species on the basis of the morphology of all stages. It can be readily distinguished from *rubithoracis* and other members of the *Fraudatrix* Subgroup in the adults of both sexes by the presence of semi-erect scalelike setae on the posterior lower portion of the mesepimeron *(mep)*; the male by the small tuft of narrow, pointed scales of the antennal flagellomere 5 and the absence of dorsal upright setae on the proboscis; the male genitalia by the long thumblike apical lobe of the paraproct of the proctiger; the pupa by the dark brown cephalothorax and abdomen and in the larva by the single seta 5-C, the dark, flattened and plumose branches of seta 7-C; the double seta 3-P and the double seta 7-I.

BIONOMICS. According to Colless (1965: 283), the larvae of *niger* have been found on one occasion amongst lotus leaves at the edge of a partly shaded swamp in association with the *rubithoracis* larvae. Nothing is known about the adult biology.

9. *CULEX (LOPHOCERAOMYIA) GIBBULUS* DELFINADO
(Fig. 11)

Culex (Lophoceraomyia) gibbulus Delfinado 1966: 106 (♂*).

FEMALE. Unknown.

MALE (Fig. 11). Wing: 2.7 mm. As described by Delfinado (1966: 105-6), with the following additional description and corrections. *Head*. Vertex

with broad pale scales restricted to eye margin, forming distinct ocular line; narrow decumbent scales numerous, occupying an extensive area in center; lateral patch of broad scales distinct. *Palpus*. As long as proboscis; basal fingerlike process of segment 1 about 0.5 of the distal part of the segment; segment 3 with 1, 2 dark, short, ventrolateral bristles subapically; segments 4 and 5 very weakly plumose, with a few dark, short bristles on lateral and mesal surfaces. *Proboscis*. Labium without dorsal upright setae; labial basal setae relatively long. *Antenna*. Flagellar whorls moderately plumose; F-5 with a small tuft of 4, 5 narrow, dark, hairlike setae, slightly longer than the combined length of the next 3 flagellomeres; modified tufts of F-6, 7 as described for the group, comb tuft of F-7 with about 14 curled setae, 4 dorsalmost of which are strong and long, the remainder weaker and shorter; F-8 with normal J-hooked tuft; F-9 with 4 yellowish bladelike scales; F-10 with 2, 3 bristlelike setae. *Thorax*. Integument of mesonotum brownish, mesonotal scales narrow, same color as integument. Pleuron same color as mesonotum; *ppl* bristles 3; 1 lower *mep* bristle present. *Legs*. As in *rubithoracis*. *Wing*. Plume scales of veins R_2, R_3 small, clavate. *Abdomen*. Terga entirely dark, sterna pale yellowish.

MALE GENITALIA (Fig. 11). *Segment IX*. Sternum broad, with a transverse row of 10 strong setae towards caudal margin; tergal lobe small, bearing a few weak setae. *Basimere*. Small, normal, conical; inner tergal surface with 1 strong submarginal seta. *Subapical Lobe*. Elongate; rodlike setae *a-c* relatively long; setae in group *d-f* 4, 5, placed on a hairy, elongate tubercle or stem, leaflet g_2 bladelike, club-shaped; leaflet g_1 (or external leaf) absent or not developed; seta *h* strong. *Distimere*. Normal, relatively long, nearly as long as basimere. *Phallosome*. Apical dorsal beaklike process of lateral plate moderate in length and thickness as in *rubithoracis*. *Proctiger*. Crown relatively larger, with 5, 6 coarse spicules laterally and several fine pointed spicules internally; paraproct narrow, without distinct apical lobe; cercal setae 2.

PUPA and LARVA. Unknown.

TYPE-DATA. Holotype ♂* with slide of antenna and genitalia, San Jose, *Mindoro*, PHILIPPINES, March 9, 1945, E. S. Ross (USNM).

DISTRIBUTION. Known only from Mindoro (type-locality) and Palawan, the Philippines. 2 specimens examined: 2♂.

PHILIPPINES. *Mindoro:* San Jose; 1♂ (holotype); *Palawan:* Brook's Point, Uring-Uring; 1 slide of ♂ antenna and genitalia, rest of specimen lost.

TAXONOMIC DISCUSSION. *Culex gibbulus* is readily separated from the other 2 members of the *rubithoracis* complex, *rubithoracis* and *niger* in the male (the only known stage), by the peculiar development of the comb-shaped tuft of antennal flagellomere 7, the absence of leaflet g_1 and the elongation of the distal part of the subapical lobe of the genitalia. The male of *gibbulus* also strikingly differs from *rubithoracis* in the complete absence of the dorsal upright setae of the proboscis, the presence of a lower mesepimeral bristle and the dark brown coloration of the thorax; from *niger* in the smaller tuft of antennal flagellomere 5, paler coloration of the thorax and the absence of the minute patch of the semi-erect scalelike setae on the lower posterior portion of mesepimeron. In the overall male morphology, *gibbulus* apparently exhibits stronger affinity with the 2 members of the *rubithoracis* complex than with the other members of the *Fraudatrix* Subgroup. It is tentatively assigned to this complex, pending a thorough knowledge of the immature stages.

BIONOMICS. Nothing is known about the biology of *gibbulus*.

inculus complex

10. *CULEX (LOPHOCERAOMYIA) INCULUS* COLLESS
(Figs. 12, 13)

Culex (Lophoceraomyia) inculus Colless 1965: 280 (♂*, ♀, L*).

FEMALE. Wing: 2.5 mm. Forefemur: 1.1 mm. Proboscis: 1.6 mm. Small, blackish species. *Head*. Decumbent scales on dorsum of vertex large-ly broad and dark, not forming a distinct ocular line; lateral patch of broad scales whitish, very distinct. Labial basal setae of proboscis strong, nearly as long as palpus. *Cibarial Armature*. Not studied. *Thorax*. Mesonotal integument dark brown to black, scales narrow and black. One lower *mep* bristle present. *Legs* and *Wing*. Without any marked coloration. *Abdomen*. Terga entirely dark; basolateral pale spots present on terga II-VII; sterna sil-very white scaled.

MALE (Fig. 12). As described by Colless (1965: 280-1); distinctive in the following features. *Palpus*. Longer than proboscis by a little more than the length of segment 5; basal fingerlike processes distinct, relatively long, as long as the distal part of segment 1; segment 3 with 6, 7 ventrolateral bristles subapically; segments 4 and 5 moderately plumose. *Proboscis*. Dorsal up-right setae present in apical 0.5 of labium. *Antenna*. Flagellar whorls strongly plumose; F-5 with a small dark tuft of 8-10 narrow, acute scales of variable length, longest ones as long as the next 2 flagellomeres; F-8 with a relatively thick J-hooked tuft of 9 proximally fused setae; F-9 with 3, 4 dark bladelike scales; F-10 with 3 strong bristlelike setae.

MALE GENITALIA (Fig. 12). Very distinctive. *Segment IX*. Tergal lobe with 4, 5 very strong setae; sternum without any scales or setae. *Basimere*. Modified conical shaped; basal half strongly swollen, with a pronounced convex tergomesal margin, apical half narrowed; submarginal setae very strong, 10-13 in number, in 1, 2 prominent rows on convex tergomesal margin; marginal setae numerous and dense; bristles and setae on lateral tergal surface relative-ly stronger than most forms. *Subapical Lobe*. All specialized setae well de-veloped; leaflets g_1 and g_2 very prominent; g_2 club-shaped, distally broad and bent upwards; g_1 broad, acuminate. *Distimere*. Stout, more or less straight or not strongly curved in middle. *Phallosome*. Apical dorsal process anvil-shaped, lightly or strongly imbricate with irregular ridges or folds, ventral surface of elongate tergal beaklike process provided with several tiny spines. *Proctiger*. Crown well developed, medium sized, with several fine pointed spicules; apex of paraproct without differentiated apical lobes; cercal sclerite broad, well sclerotized; cercal setae 1, 2.

PUPA (Fig. 13). Abdomen: 2.3 mm. Paddle: 0.60 mm. Trumpet: 0.52 mm; index 10. In general as described for the group. Cephalothorax and abdo-men pale yellow or cream-colored. *Trumpet*. Brownish, cylindrical or slight-ly widened towards apex. *Cephalothorax*. Setae 1, 3-C double; 5-C triple; 8, 9-C double. *Metanotum*. Setae 10, 11-C double. *Abdomen*. Seta 5-IV 4, 5 branched; 5-V, VI double; 6-III, IV double; 6-V, VI usually double (2-3); 4-VIII single or double. *Paddle*. Very pale to almost transparent, midrib weak and lightly pigmented.

LARVA (Fig. 13). Head: 0.65 mm. Siphon: 1.0 mm; index 6. Saddle: 0.26 mm; siphon/saddle ratio 4. Generally conforms to the group, with the following diagnostic features. *Head*. Seta 4-C minute, 0.25 of the distance

between bases of the pair; 5-C single; 14-C double. *Thorax.* Unspiculated; seta 3-P single; 4-P single. *Abdomen.* Seta 7-I single; 6-III-VI usually triple (3-4). Comb scales 40, normal. Saddle seta 2-X with 1 short and 1 long branch; 4-X with 6 pairs of setae. *Siphon.* Uniformly yellowish, without median dark band and moderately long; pecten teeth 14-16, distal teeth with 1, 2 strong basal denticles and 6, 7 distal denticles; subventral tuft strong, prominent, 4 pairs, all more or less subequal, 5-7 branched each, about 1.5 times as long as siphonal width at points of attachment.

TYPE-DATA. Holotype ♂* (604/20) with associated larval and pupal skins, slides of antenna (CH 132) and genitalia (CT 427), Kampong Sireh, *Selangor, Malaya* [MALAYSIA], March 31, 1953, J. A. Reid, Australian National Insect Collection, Canberra (ANIC).

DISTRIBUTION. Malaysia and Cambodia; 3 specimens examined: 2♂ (including holotype), 1♀; 2 with associated larval and pupal skins.

MALAYSIA. *Peninsular Malaysia* - Selangor; 1♂, 1♀, 2 lp (type-series).

CAMBODIA. Sihanoukville; 1♂ (only antenna and genitalia slide, collector: J. M. Klein, 15 Jan. 67).

TAXONOMIC DISCUSSION. *Culex inculus* is strongly differentiated from the rest of the *Fraudatrix* Subgroup by the peculiar anvil-shape of the male phallosome and by several other features of the male genitalia as described above. The male is somewhat intermediate between the *rubithoracis* and *quadripalpis* complexes in the characters of the palpus and the antennal tuft of flagellomere 5 and in the chaetotaxy of the larva. The female resembles *reidi* in the *quadripalpis* complex more than any others and cannot be distinguished from that species with certainty. This species can be well assigned to the *quadripalpis* complex but because of the very distinctive male genitalia, it seems to represent a distinct line or separate complex.

BIONOMICS. *Culex inculus* is a rare species as it has been collected only twice, once from the type-locality in Malaysia and once from Cambodia. In Selangor, Malaysia, the immatures of *inculus* were collected from pools in a nipa palm swamp in association with specimens of *reidi* (Colless 1965: 281). In Cambodia, the single male was incidentally collected by sweeping with a net in a forest along the sea coast. Nothing is known about the adult biology and its medical importance.

quadripalpis complex

11. *CULEX (LOPHOCERAOMYIA) QUADRIPALPIS* (EDWARDS) (Figs. 14, 15)

Lophoceratomyia sylvestris Leicester 1908: 125 (♂, ♀; non Theobald 1901).
Lophoceratomyia quadripalpis Edwards 1914a: 80 (♂).
Culex (Lophoceratomyia) quadripalpis Edwards 1922a: 280 (key); Edwards 1922b: 473 (synopsis); Edwards 1932: 197 (taxonomy).
Culex (Lophoceraomyia) quadripalpis (Edwards), Mattingly 1949: 227 (L*); Stone, Knight and Starcke 1959: 235 (catalog); Colless 1965: 285 (♂*, ♀, L*); Bram 1967a: 65 (♂*, ♀, L*).
Culex (Lophoceratomyia) roubaudi Borel 1926: 112 (♂*, ♀, L*); Borel 1930: 362 (♂*, ♀, L*); Edwards 1932: 197 (synonymy).
Culex (Lophoceratomyia) pachecoi Baisas 1935: 171 (♂*, ♀); Bohart 1945: 76 (♂*, key); Stone, Knight and Starke 1959: 235 (catalog); Delfinado 1966: 112 (♂*, P, L). NEW SYNONYMY.

Culex (Lophoceratomyia) barkerii (Theobald 1907), in part of Edwards 1913: 236 (taxonomy); Edwards 1917: 227 (taxonomy).

FEMALE. Wing: 3.0-4.0 mm (average 3.5 mm). Forefemur: 1.7 mm. Proboscis: 2.0 mm. Medium or large sized species, color dark brownish to blackish; generally conforms to the *Fraudatrix* Subgroup. *Head*. Vertex with a narrow band of broad pale scales forming distinct ocular line along upper eye margin; narrow decumbent scales numerous, predominantly dark, occupying an extensive area in center; erect scales coarse and blackish; lateral patch of broad scales whitish, very distinct. Palpus about 0.2 of proboscis length. Proboscis with 4 labial basal setae, 2 lateral ones strong, 0.5 of palpal length, 2 median ones shorter. *Cibarial Armature* (Fig. 14). Cibarial teeth numerous, 60 or more, all of which are narrow, subequal, apically blunt or pointed, in a close-set row. *Thorax*. Mesonotal integument dark brown; mesonotal scales narrow, dense and entirely blackish. *Ppn* without scales or setae cephalad of posterior bristles. Pleuron same color as mesonotum, scales practically absent; *ppl* with 3 bristles and 8-10 weak setae; 1 lower *mep* bristle present, sometimes 2. *Legs*. Dark, without marked coloration; anterior surface of hindfemur with a broad pale stripe extending from base to apex. *Wing*. Scales dark, narrow and relatively dense on all veins; plume scales on veins R_2, R_3 rather narrow, linear. *Abdomen*. Terga entirely dark; basolateral pale spots present or sometimes absent; sterna yellowish scaled.

MALE (Fig. 14). In general as described for the female. *Head*. Ocular line of vertex wider, narrow decumbent scales paler. *Palpus*. Length varying from as long as to longer than proboscis by the full length of segment 5; basal fingerlike process rather thick and relatively long, reaching slightly beyond apex of segment 1; segment 3 with 3, 4 ventrolateral bristles subapically; segments 3 and 4 weakly to moderately plumose. *Proboscis*. Dorsal upright setae well developed, numerous, forming a dense double row in distal 0.75 of total length; most distal setae longest, 2, 3 times as long as labial width at point of attachment; labial basal setae 12. *Antenna*. Flagellar whorls densely long plumose, modified tuft of F-5 variable, usually very distinct, with some broad dark scales and lanceolate setae; 3, 4 dorsalmost scales long, blunt tipped or abruptly pointed, as long as the combined length of the next 4 flagellomeres, followed laterally by 3 acute lanceolate scales of decreasing length and 1 dark, longer bristlelike seta; F-6, 7 with usual crumpled tufts of setae as described for the subgroup; F-8 with relatively thick J-hooked tufts of 6-8 fused setae; F-9 with 4, 5 yellowish bladelike scales; F-10 with 3, 4 long bristlelike setae.

MALE GENITALIA (Fig. 14). *Segment IX*. Tergal lobe small, with 3, 4 short, weak setae; sternum usually bare, sometimes with a few setae towards caudal margin. *Basimere*. Normal, conical; with a prominent row of 6-8 strong submarginal setae on inner tergal surface; marginal setae 6, 7, all weak, short, widely spaced on tergomesal margin. *Subapical Lobe*. Rodlike setae *a-c* of proximal part stout, subequal, smoothly curved, with hooked or truncate apices; several fine hairlike setae present at bases of rods on mesal surface; distal part with 1 hairlike and 4 bladelike setae in group *d-f*; leaflet g_2 distally broad, spatulate; leaflet g_1 well developed, broad, apex blunt or acuminate; seta *h* strong and long. *Distimere*. Normal, rather thick, gently or strongly curved in middle; subapical claw short, distally dilated; 1 ventral and 1 dorsal tiny seta present at 0.75 from base; dorsal subapical surface very lightly serrated. *Phallosome*. Apical dorsal beaklike process of labial plate moderately thick and long, posterior margin with or without minute spicules. *Proc-*

tiger. Crown small, with a distinct tuft of few flat and several spinelike spicules; apex of paraproct with a short, broadly rounded, apical sternal lobe and a poorly developed external lobe; cercal setae usually 3, 4, sometimes 2.

PUPA (Fig. 14). Abdomen: 2.5 mm. Paddle: 0.70 mm. Trumpet: 0.78 mm; index about 12. Cream-colored or yellowish white. *Trumpet*. Relatively long, uniformly cylindrical. *Cephalothorax*. Seta 1-C usually 4 branched (3-4); 8, 9-C double. *Metanotum*. Setae 10, 11-C double. Abdomen. Seta 6-III-VI usually 4, 5 branched (3-6); 5-IV usually 7 branched (7-8); 5-V usually 5 branched (4-7); 5-VI double; 9-VII usually 4 branched (4-5); 4-VIII usually double (2-3). *Paddle*. Entirely pale, without infuscate areas; midrib weak, moderately pigmented or same color as outer and inner parts of paddle.

LARVA (Fig. 15). Head: 0.76 mm. Siphon: 1.8-2.0 mm; index 9-10. Saddle: 0.30 mm; siphon/saddle ratio 5-6. In general as described for the group with the following diagnostic features. *Head*. Yellowish white; seta 4-C 0.5 or more of the distance between bases of the pair, single or bifid; 5, 6-C double; 7-C usually 6, 7 branched (5-8), all branches narrow and weakly pectinate; 14-C double. *Thorax*. Spiculation absent; seta 3-P usually single, rarely double; 4-P usually single (1-2); 14-P single or double. Abdomen. Seta 6-I, II usually triple (3-4); 7-I double; 1-III-VI usually 4, 5 branched (3-7); 6-IV-VI usually 4 branched (3-6). Comb scales 30-40, all subequal, with apical fringe of evenly fine spicules. Saddle yellowish white, seta 2-X with 1 short and 1 long branch; ventral brush (4-X) with 6 pairs of setae; anal gills as long as saddle. *Siphon*. Slender, long, usually with median dark ring, pecten teeth 11-15, distal tooth with 2, 3 strong basal denticles and 4-6 fine, graded denticles distally; subventral tufts 4 pairs (total 8), 2-4 branched each, as long as or slightly longer than siphonal width at points of attachment; 2-5 short and weak; median caudal filament of spiracular apparatus very well developed.

TYPE-DATA. (1) *Lophoceratomyia sylvestris* Leicester; Lectotype ♂* with slide of genitalia, Kuala Lumpur, (*Selangor*), *Malaya* [MALAYSIA], pool in hillside stream, Pahang Rd. jungle November 23, 1903, G. F. Leicester (BMNH; selection of Colless 1965: 285). (2) *Lophoceratomyia quadripalpis* Edwards; Holotype ♂* with slide of antenna and genitalia, *Sarawak*, N. Borneo [MALAYSIA], 1908, J. Hewitt (BMNH). (3) *Culex (Lophoceratomyia) roubaudi* Borel; Type non-existent, Terres Rouges, Cochin-China, [VIETNAM]. (4) *Culex (Lophoceratomyia) pachecoi* Baisas 1935; Lectotype ♂* (F-150), marked as paratype, with slide of antenna and genitalia, College of Agriculture, Los Banos, Laguna, *Luzon*, PHILIPPINES, larva breeds in semi-stagnant edges of forest creeks, February 2, 1935, F. E. Baisas (USNM; present selection).

DISTRIBUTION. Sri Lanka, Thailand, Malaysia and the Philippines; also reported from Vietnam, Singapore, Indonesia (Sulawesi). 160 specimens examined: 71♂, 22♀, 67 L; 54 with associated immature skins (19 p, 35 lp).

SRI LANKA. *Western Province:* Colombo District, Labugama; 1♂, 3♀.

THAILAND. *Chiang Mai:* Doi Sutep; *Khon Kaen:* Phuweang; *Nakhon Ratchasima:* Khao Yai; Ban Khanong, Phra Nua; Khlong Pai; Kabinburi Pak Thong Chai; Khao Saladi; *Nakhon Nayok:* Khao Yai; *Phangnga:* Nam Tai; *Songkhla; Satun; Narathiwat:* Khau Lau; 23♂, 16♀, 65 L, 19 p, 15 lp.

MALAYSIA. *Peninsular Malaysia - Selangor:* Ulu Gombak; *Pahang:* Gunong Benom; Sungai Temau; *Perak:* Chior F. R.; *Kedah:* Sintok F. R.; 8♂, 6♀, 1 L, 2 p, 1 lp. *Malaysia* (Borneo) - *Sarawak:* Kuching; *Sabah:* Tawau; N. Kalabakan; Sandakan Bay, Sepilak F. R.; 17♂.

PHILIPPINES. *Luzon:* Laguna, Los Banos, College of Agriculture; Malawin Creek, Mt. Makiling; *Palawan:* Puerto Princesa; Iwahig; Cabayuyan;

Ludlow Barracks; 22♂, 7♀, 1 L, 9 lp.

Additional records from the literature. VIETNAM (as *roubaudi*, Borel 1930: 362); SINGAPORE (Colless 1965: 286); INDONESIA: Sulawesi (Celebes) (Brug and Bonne-Wepster 1947: 186).

TAXONOMIC DISCUSSION. I am following Edwards (1932) and subsequent authors (Stone, Knight and Starcke 1959, Colless 1965, Bram 1967a) in using the name *"quadripalpis"* for this species in spite of the fact that there are some dubious points about its validity as pointed out by Colless (1965: 286). Although the earlier name *"sylvestris"* Leicester was apparently the one to be adopted after it had been removed from the synonymy with *Culex sylvestris* Theobald which is an *Aedes*, there was, however, no indication that *"sylvestris"* was ever resurrected by Edwards (1922a, 1922b, 1932). In the earlier paper, Edwards (1917: 237) had considered both *sylvestris* and *quadripalpis* to be synonymous with *barkerii* Theobald, but later in his world catalog (Edwards 1932: 197), he revalidated *quadripalpis* and listed *barkerii* and *sylvestris* as its synonyms. It seems that Edwards' final action was based purely on the grounds that the status of *quadripalpis* was more stable and had been more frequently used than the other 2 names. Edwards' treatment appears to be justified except for the synonymy of *barkerii* Theobald which was clearly unwarranted as indicated in the discussion by Colless (1965).

Culex quadripalpis is apparently one of the widespread Southeast Asian species. It exhibits a great range of variation in the number and size of the modified tufts of male antennal flagellomere 5, overlapping with the members of the *rubithoracis* complex and the other members of the *quadripalpis* complex. It can, however, be readily recognized in the male genitalia by the prominent row of 6-8 strong submarginal setae of the basimere, the stout, moderately long apical dorsal beaklike process of the phallosome and by the broadly rounded apical sternal lobe of the paraproct of the proctiger. The female and pupa do not appear to show any striking difference from other members of its own complex, but can be distinguished from most members in the other complexes of the *Fraudatrix* Subgroup by the numerous, fine cibarial teeth of the females and by the combination of characters of the pupa as described above. The larva is very distinct from other complexes, particularly in having seta 4-P single, 14-P single or double and the relatively long siphon.

The newly proposed synonymy of the Philippine *pachecoi* Baisas with *quadripalpis* above is only tentative, based partly on the similarity in several details of the male genitalia and the immature stages. In comparing the males of both forms, I found that *pachecoi* differs slightly from the typical *quadripalpis* in usually having fewer, narrower, finely pointed scales in the modified tuft of antennal flagellomere 5, more or less resembling some members of *rubithoracis* complex, and in the weaker modified tufts of antennal flagellomeres 6-8. However, there is also some overlap in all of these features. It is quite probable that the *patchecoi* form is only subspecifically distinct and that it probably represents a local or geographic segregate of a single widespread species.

BIONOMICS. The breeding site of *quadripalpis* ranges from small ground pools, rock pools along stream margins to large bodies of water such as flooded grounds, seepage ponds and swamps. These habitats are usually under heavy shade of tropical forest, containing numerous leaves, fallen trunks or branches of trees. The adults were collected while resting on leaves or bushes near the breeding sites and do not appear to be attracted to light. In Malaysia, Colless (1965: 286) noted that adults occasionally attack man.

12. *CULEX (LOPHOCERAOMYIA) ACULEATUS* COLLESS
(Fig. 16)

Culex (Lophoceraomyia) aculeatus Colless 1965: 286 (♂*, ♀, L*); Bram 1967a: 50 (♂*, ♀, L*).

FEMALE. Wing: 2.7 mm. Forefemur: 1.2 mm. Proboscis: 1.55 mm. Extremely similar to *quadripalpis*, differing in relatively smaller size and in the following. *Head*. Erect scales of vertex finer. *Cibarial Armature*. As figured for *quadripalpis*, cibarial bar narrower, with a close-set row of 35-40 teeth which are stronger and apically pointed. *Thorax*. *Ppl* with 1, 2 bristles and 4, 5 weak setae. *Wing*. Plume scales on veins R_2, R_3 finer; scales on most veins rather sparse. *Abdomen*. Terga entirely dark, basolateral spots completely absent.

MALE (Fig. 16). As described for female, differing from *quadripalpis* particularly in the following features. *Palpus*. More slender; basal fingerlike process of segment 1 apparently shorter, not exceeding apex of the segment; segments 4 and 5 weakly plumose, with fewer bristles on lateral and mesal surface. *Proboscis*. Dorsal upright setae in distal portion of labium fewer and shorter; labial basal setae weaker, more or less hairlike, but not spine-like. *Antenna*. Flagellar whorls moderately plumose; F-5 always with prominent tuft of 6-8 dark scales, dorsalmost 3, 4 scales broad, apically blunt, usually slightly exceeding the combined length of the next 3 flagellomeres, sometimes as long as the next 4 flagellomeres; followed laterally by 3, 4 lanceolate or apically pointed scales of decreasing length; 2, 3 setae among normal long hairs of inner whorl of F-5 dark, flattened, very strong and distinct; F-8 with a strong J-hooked tuft of 6, 8 fused setae; F-9 with 3, 4 long, yellowish, bladelike scales; F-10 with 2, 3 bristlelike setae.

MALE GENITALIA (Fig. 16). Rather slender and small, differing from *quadripalpis* strikingly in having only 3 submarginal setae on the inner tergal surface of basimere and in the following details. *Segment IX*. Tergal lobe very poorly developed, bearing 2 tiny setae; sternum with or without a row of strong setae near caudal margin. *Basimere*. More slender; inner tergal surface with 3 moderately strong submarginal setae in a row on its inner tergal surface; sometimes with 1 other weaker seta in addition. *Subapical Lobe*. Leaflets g_1, g_2 of distal part broad, foliate, with acute apices; g_2 with apex drawn out into a filament. *Distimere*. Slender and gently curved in apical 0.5; subapical claw short. *Phallosome*. Very distinctive; apical dorsal beak-like process of lateral plate very long, thin, distally tapering into a sharp point. *Proctiger*. Lateral spicules of crown coarser; apex of paraproct with a distinct lateral lobe which is well sclerotized, elongate, somewhat tongue-like; cercal setae 3.

PUPA. Abdomen: 2.3 mm. Paddle: 0.62 mm. Trumpet: 0.66 mm; index 10. Essentially as figured and described for *quadripalpis*, differing slightly in the following. *Cephalothorax*. Seta 1-C 4, 5 branched; 5-C 4-6 branched. *Abdomen*. Seta 5-IV 5-6 branched; 9-VII usually triple (3-4).

LARVA. Head: 0.70 mm. Siphon: 1.4-1.6 mm; index 8-10. Saddle: 0.3 mm; siphon/saddle 5. As figured and described for *quadripalpis*, differing from it particularly in the following. *Head*. Seta 14-C usually triple or 4, 5 branched. *Thorax*. Seta 3-P usually double, rarely single; 14-P always single. *Abdomen*. Seta 6-I always triple. Saddle seta 2-X with 2, 3 short branches and 1 long branch. *Siphon*. Relatively shorter and with lower index

and siphon/saddle ratio; pigmentation uniformly yellowish in proximal and distal portion, median dark ring usually absent; subventral tufts weaker and shorter, double or triple, as long as siphonal width at point of attachment.

TYPE-DATA. Holotype ♂ with associated pupal and larval skins and slide of antenna and genitalia, Kg. Gajah F. R. *Perak, Malaya* [MALAYSIA], November 13, 1958, D. H. Colless (ANIC).

DISTRIBUTION. Thailand and Malaysia, not known elsewhere. 116 specimens examined: 53♂, 27♀, 36 L; 33 with associated immature skins (19 P, 14 lp).

THAILAND. *Chiang Mai:* Doi Sutep; *Lampang:* Ngao; Tak: Doi Sam Sao; Khao Salak Phra; Huai Lan Lang; *Nakhon Ratchasima:* Khao Yai; *Prachin Buri:* Ban Tung Fack; *Chanthaburi:* Ban Bo Phu Pit; Ban Chak Yai; Khao Sai Dao; *Ranong:* Khao Hin Chong; *Trang:* Muang; *Phangnga:* Khao Soong; *Phuket:* Khao Prathin; Bang Khian; *Prachaup Khiri Khan:* Klong Hin Chong; *Songkhla:* Ratta Poom; *Yala:* Yala Bong; Stun; *Narathiwat:* Khau Lau; 36♂, 11♀, 36 L, 18 p, 8 lp.

MALAYSIA. *Peninsular Malaysia - Selangor:* Ulu Gombak; Ampang F. R.; *Pahang:* Gunong Benom; *Perak:* Chior F. R.; 13♂, 16♀, 1 p, 6 lp. *Malaysia - Sabah:* Tawau; 4♂.

TAXONOMIC DISCUSSION. *Culex aculeatus* is strongly differentiated from the rest of the *quadripalpis* complex especially by the long, very slender apical dorsal beaklike process of the male phallosome. The other male features which are also very diagnostic of *aculeatus* are the presence of 2, 3 dark flattened setae on the inner whorls of antennal flagellomere 5 (fine, thin, hairlike in all others of the complex) and the elongate, tongue-like apical lobe of the paraproct of the proctiger. The female cannot be separated from *quadripalpis* with certainty on the external characters, but is obviously different from it in having fewer cibarial teeth as described and figured here. Both the larva and pupa of *aculeatus* exhibit considerable overlap with those of *quadripalpis* from which it can be clearly separated by using the combinations of the usual characters of the setae and other general features as indicated in the above description.

There is apparently little variation in the diagnostic characters of *aculeatus* and all of the specimens which have been identified as this species essentially conform to a single type. Although *aculeatus* is known only from Thailand and Malaysia, there is a possibility that it may be widespread, extending into other areas of Southeast Asia.

BIONOMICS. The immatures of *aculeatus* have been frequently collected from pools at the edges of streams and occasionally from swamps, marshy depressions and rock pools. These breeding sites which are under heavy shade usually contain aquatic vegetation, decayed leaves and fallen branches of trees and are at a high elevation. At Khao Yai, Nakhon Ratchasima, Thailand, specimens were collected at an elevation of 1,200 m. A number of the adults were collected resting on vegetation and from sweeping with a net among bushes near the breeding sites. The females are not known to bite man.

13. *CULEX (LOPHOCERAOMYIA) PARACULEATUS* NEW SPECIES
(Fig. 16)

Culex (Lophoceratomyia) fraudatrix of Baisas 1935: 173 (♂*, ♀).

FEMALE. Unknown.

MALE (Fig. 16). Exceedingly similar to *aculeatus* in the details of antenna,

palpus, proboscis and general facies; differing slightly in the following. *Palpus*. Basal fingerlike processes thicker and longer, nearly reaching the apex of segment 1. *Proboscis*. Distal 0.75 of labium with more numerous dorsal upright setae. *Antenna*. Setae among normal long hairs of inner whorl of F-5 all fine, hairlike; modified tuft with 4-6 dark scales, 2, 3 dorsalmost scales longest and apically blunt, slightly longer than the combined length of the next 3 flagellomeres, 2-3 lateral ones shorter, lanceolate; F-7 with weak, markedly reduced tuft of curled setae; F-8 with more slender J-hooked tuft, consisting of only 4 dark, fused setae.

MALE GENITALIA (Fig. 16). As figured, exceedingly similar to *aculeatus*; differing chiefly in the following. *Subapical Lobe*. Leaflet g_2 narrow in basal 0.5, broad spatulate in apical 0.5, apex blunt. *Phallosome*. Apical dorsal beaklike process much shorter, more or less resembling that of *quadripalpis*. *Proctiger*. Apical sternal and lateral lobes of paraproct short and rounded; crown with weaker and fewer spicules.

PUPA and LARVA. Unknown.

TYPE-DATA. Holotype ♂ (B60/22) with slide of antenna and genitalia (SEAMP 69/106), *Tawau, (Sabah)*, North Borneo, [MALAYSIA], February 1960, D. H. Colless (BMNH). Paratype 1♂ (B60/22) with slide of head, palpus, proboscis and genitalia (SEAMP 69/107), same data as holotype (USNM).

DISTRIBUTION. Malaysia (Sabah) and the Philippines (Leyte, Mindanao). specimens examined: 4♂.

MALAYSIA. *Sabah;* 2♂, as indicated in the type-data.

PHILIPPINES. *Leyte:* Diit River, Tacloban, 1♂; *Mindanao:* Parang, 1♂.

TAXONOMIC DISCUSSION. *Culex paraculeatus* is recognized as distinct from *aculeatus* on the basis of the difference in the considerably shorter and stronger apical beaklike process of the male phallosome and in the markedly reduced tufts of antennal flagellomere 7. The 2 males from the Philippines undoubtedly belong to this species since they agree well with the males in the type-series in the genitalic characters. At the type-locality in Tawau, Sabah, *paraculeatus* was found to be sympatric with *aculeatus* without intergradation in their diagnostic features. The Philippine specimens described by Baisas (1935: 173) as *fraudatrix* apparently belong to this species judging by his figures of the male antenna and genitalia.

BIONOMICS. The males of *paraculeatus* came from collecting with a sweep net among leaves of plants in a tropical rain forest.

14. *CULEX (LOPHOCERAOMYIA) AESTIVUS* NEW SPECIES
(Fig. 17)

FEMALE. Unknown.

MALE (Fig. 17). Exceedingly similar to *aculeatus* and *paraculeatus* in most features of the antenna, palpus, proboscis and general facies; differing from both particularly in the following. *Antenna*. Modified tuft of F-5 with all broad, dark scales abruptly ended into a fine point; inner whorl of normal long hairs of F-5 as in *paraculeatus;* F-8 with a strong J-hooked tuft, consisting of 8 dark, fused setae.

MALE GENITALIA (Fig. 17). As figured, differing from *aculeatus* and *paraculeatus* particularly in the following. *Basimere*. Inner tergal surface with only 1 submarginal seta. *Subapical Lobe*. Leaflet g_1 of distal part absent or not developed, g_2 broad, foliate, apically drawn out into a fine point, as in *aculeatus*. *Phallosome*. Apical dorsal beaklike process short and stout,

as in *paraculeatus* but apparently heavier. *Proctiger*. Crown smaller, with fewer and finer spinelike spicules; paraproct with distinct lateral apical lobe which is longer than *paraculeatus* but shorter than *aculeatus*.

PUPA and LARVA. Unknown.

TYPE-DATA. Holotype ♂ with slide of antenna and genitalia (SEAMP 69/105), Long Tebangan, *Sarawak*, MALAYSIA, June-July, 1953, D. H. Colless (BMNH).

DISTRIBUTION. Known only from the type-locality. 1♂ examined, as indicated in the type-data.

TAXONOMIC DISCUSSION. *Culex aestivus* is somewhat intermediate between *aculeatus* and *paraculeatus* but is distinct from both in the presence of 1 submarginal seta on the basimere and the absence of leaflet g_1 in the distal part of the subapical lobe of the male genitalia. Although *aestivus* is known from a single male, it appears to be distinct. There is no indication that its diagnostic features specified above fall into the range of variation of *aculeatus* or *paraculeatus*.

BIONOMICS. The single male of *aestivus* was collected in the field while resting among shrubs.

15. *CULEX (LOPHOCERAOMYIA) REIDI* COLLESS
(Fig. 18)

Culex (Lophoceraomyia) reidi Colless 1965: 279 (♂*, ♀, L*); Delfinado 1966: 113 (♂*); Bram 1967a: 66 (♂*, ♀, L*).

Culex (Lophoceratomyia) quadripalpis of Edwards and Given 1928: 352 (L, misidentification).

FEMALE. Wing: 2.7 mm. Forefemur: 1.3 mm. Proboscis: 1.7 mm. In general as described for the complex and subgroup, not readily distinguished from other species. *Head*. Vertex largely covered with dark, broad decumbent scales; not forming a distinct ocular line; narrow decumbent scales restricted to occiput; erect scales dark or blackish, lateral patch of broad scales predominantly dark, not distinct. Palpus relatively short, about 0.15 of proboscis length. Proboscis with 2 labial basal setae, both of which are dark, about 0.5 of palpal length. *Cibarial Armature*. Not studied. *Thorax*. Mesonotal integument and scales dark brown. Pleuron slightly paler than mesonotum; 1 lower *mep* bristle present. *Legs*. Without marked coloration; anterior surface of hindfemur with a narrow longitudinal pale stripe from base to near apex. *Wing*. Scales on all wing veins moderately dense, plume scales on veins R_2, R_3 narrow, clavate. *Abdomen*. Terga entirely dark; basolateral pale spots usually absent, sometimes present on terga II-VII; sterna usually pale yellowish scaled, sometimes dusky.

MALE (Fig. 18). In general similar to female; essentially as described by Colless (1965: 279) and Bram (1967a: 66). *Palpus*. Exceeding proboscis by slightly more than the full length of segment 5; basal fingerlike processes strong and relatively long, as long as the distal part of segment 1; segment 3 with 1 strong and 2 weak bristles in apical 0.1; segments 4, 5 weakly to moderately plumose. *Proboscis*. Apical 0.5 of labium with distinct double rows of dorsal upright setae, distal setae longest, 2 times as long as labial width at point of attachment. *Antenna*. Flagellar whorls strongly long plumose; modified tuft of F-5 distinct, consists of 4-6 narrow or broad scales, all of which are tapered into a fine point, 2, 3 dorsalmost scales longest, as long as the combined

length of the next 3 flagellomeres, followed laterally by 2, 3 shorter scales and 1 narrow scale of increasing length; modified tufts of F-6 to F-10 normal, as described for the subgroup and essentially similar to *quadripalpis* and *aculeatus*.

MALE GENITALIA (Fig. 18). As figured, as described by Colless (1965: 279) and as in the following description. *Segment IX*. Tergal lobe well developed, bearing 5-7 relatively strong setae. *Basimere*. Submarginal setae usually 4, sometimes 3 or 5, all apparently flattened, strong, moderately long and heavily bent distad of middle. *Subapical Lobe*. One of the 3 rods in group *a-c* broadly expanded and strongly angulate in apical portion, other 2 rods slender, tapered into hooked apices; distal part with 5 narrow blades and 1 hairlike seta in group *d-f*; leaflet g_2 club-shaped; g_1 broad, acuminate; basal seta *(h)* weak. *Distimere*. Dorsal subapical surface with a distinct crest of fine spicules, extending from apex to middle of curvature; subapical claw short. *Phallosome*. Apical dorsal beaklike process of labial plate slender and short. *Proctiger*. Crown small, composed largely of fine, pointed spicules; apex of paraproct adjacent to crown broadly rounded, apparently without distinct external (or lateral) and sternal lobes; cercal setae 3, 4 in number.

PUPA. Abdomen: 2.3 mm. Paddle: 0.60 mm. Trumpet: 0.52 mm; index 8. As figured for *quadripalpis* (Fig. 14); pigmentation of cephalothorax and abdomen light, yellowish brown, without definite pattern of dark and light areas, trumpet darker; the following setae are diagnostic. *Cephalothorax*. Seta 1, 3-C double; 8, 9-C double. *Metanotum*. 10, 11 and 12-C double. *Abdomen*. Seta 1-III, IV 6 branched; 1-V, VI 3, 4 branched (2-4); 1-VIII 1-3 branched; 5-IV 2-4 branched; 5-V-VI double; 6-III-VI usually double, sometimes single. *Paddle*. Midrib strong and dark, inner and outer parts pale, without darkened areas.

LARVA (Fig. 18). Head: 0.70 mm. Siphon: 1.2 mm; index 9. Saddle: 0.26 mm; siphon/saddle ratio 4.5. Essentially conforms to the *quadripalpis* complex in the single seta 4-P, distinctive in the following. *Head*. Seta 4-C very short, about 1.5 of the distance between bases of the pair, placed very close to seta 6-C; usually distally forked into 2, 3 branches; 5, 6-C double, subequal; 7-C 6, 7 branched, weak; 14-C double. *Thorax*. Seta 3-P single; 4-P single; 7-P usually double (2-3); 8-P double; 14-P single. *Abdomen*. Seta 6-I, II triple; 7-I single; 6-III-VI usually triple (3-4); 1-III-VI double or triple. Comb scales about 40, all of which are subequal and with apical fringes of fine spicules. Saddle seta 2-X with 2 short branches and 1 long branch; ventral brush with 6 pairs of setae; anal gills as long as or shorter than saddle. *Siphon*. Moderately long, uniformly yellowish white or sometimes with median dark band; pecten teeth 11-12, distal teeth with 2 strong basal and 6-10 fine apical denticles; subventral tufts 4 pairs, 3-6 branched each, 3 proximal pairs subequal, slightly longer than siphonal width at points of attachment, most distal pairs shorter; median caudal filament of spiracular apparatus well developed.

TYPE-DATA. Holotype ♂ with associated larval and pupal skins and slide of antenna and genitalia (CT544), SINGAPORE, reared from a single egg-raft, December 18, 1956, D. H. Colless (ANIC).

DISTRIBUTION. Thailand, Malaysia, Singapore and the Philippines; 22 specimens examined: 6♂, 2♀, 14 L; 5 with associated immature skins (1 p, 5 lp).

THAILAND. *Bangkok:* Pathumwan; Bang Khun Non; Bang Mod; *Thonburi:* Bangkok Noi; *Chanthaburi:* Ban Wak; 3♂, 1♀, 6 L, 1 p, 2 lp.

MALAYSIA. *Peninsular Malaysia - Selangor:* Rantau Panjang; *Perak:*

Trong; 1♂, 1♀, 6 L, 2 lp; *Malaysia - Sabah*; 1♂.

SINGAPORE. 2 L.

PHILIPPINES. *Palawan:* Uring Uring, Brooke's Point; 1♂ (genitalia only).

TAXONOMIC DISCUSSION. *Culex reidi* is differentiated from the other members of the *quadripalpis* complex in the adults of both sexes by the predominantly broad and dark decumbent scales of the vertex of head; in the male by (1) the relatively long basal fingerlike processes of palpus and (2) the pointed or acute scales of the modified tuft of antennal flagellomere 5; in the male genitalia by (1) the presence of a row of 4 markedly flattened submarginal setae; (2) one of the 3 proximal rods of the subapical lobe broadly expanded and angulate in apical portion; (3) the short and slender apical beaklike process of the phallosome and (4) apical lobe of paraproct of the proctiger broadly rounded; in the pupa by (1) the dark and strong midrib of the paddle and (2) setae 6-III-VI usually double; in the larva by (1) seta 7-P usually double and (2) seta 7-I single.

The affinity of *reidi* appears to be intermediate between the other members of the *quadripalpis* complex and *inculus*. It is very similar to *inculus* in the general facies of the adults, pupal and larval chaetotaxy but is similar to most members of the *quadripalpis* complex in several details of the male genitalia.

BIONOMICS. The breeding sites of *reidi* are fresh water ground pools in a nipa palm swamp near to or in the vicinity of the seacoast. It appears to be rather rare. Nothing is known about adult biology.

variatus complex

16. *CULEX (LOPHOCERAOMYIA) VARIATUS* (LEICESTER)

(Figs. 19, 20)

Lophoceratomyia variata Leicester 1908: 121 (♂, ♀).

Lophoceratomyia fraudatrix Theobald 1905b, Edwards 1913: 235 (as senior homonym of *L. variata* Leicester).

Culex (Lophoceratomyia) fraudatrix Theobald of Barraud 1924: 41 (♂*); Edwards and Given 1928: 351 (L); Edwards 1932: 197 (taxonomy); Barraud 1934: 368 (♂*, ♀, L); Brug and Bonne-Wepster 1947: 186 (distribution, in part); Chu 1957: 151 (♂*, distribution).

Culex (Lophoceraomyia) fraudatrix Theobald, Stone, Knight and Starcke 1959: 233 (catalog).

Culex (Lophoceraomyia) variatus (Leicester), Colless 1965: 270 (♂*, ♀, L*); Bram 1967a: 72 (♂*, ♀, L*); Stone 1967: 214 (catalog).

FEMALE. Wing: 2.8-3.3 mm (average 3.0 mm). Forefemur: 1.2-1.5 mm (average 1.4 mm). Proboscis: 1.5-1.9 mm (average 1.75 mm). Medium to large sized in the subgenus; generally conforms to the description of the *Fraudatrix* Group. *Head*. Decumbent scales of vertex largely broad and dark, sometimes partially pale along upper eye margin, forming a distinct ocular line; narrow decumbent scales restricted to dorsal midline, extending anteriorly to frons and posteriorly to occiput; lateral patch of broad scales pale brown or dingy white. Palpus 0.2 of proboscis length. Proboscis with 2 labial basal setae which are 0.5 of palpal length. *Cibarial Armature* (Fig. 19). Cibarial bar with a concave row of 40-50 narrow fine teeth which are equally long and apically pointed or blunt. *Thorax*. Mesonotal integument pale brown to dark chestnut brown; scales very narrow, moderately dense and

dark except for a few pale ones on extreme anterior promontory. *Ppn* with some narrow fine scales or setae cephalad of 4, 5 posterior bristles. Pleuron same color as mesonotum; *ppl* with 3, 4 bristles and a few weak setae; 1 lower *mep* bristle present. *Legs*. Anterior surface of hindfemur with a longitudinal pale stripe extending from base to 0.5-1.0 of whole length. *Wing*. Scales moderately dense; plume scales on R_2, R_3 relatively broad clavate. *Abdomen*. Terga entirely dark; basolateral pale spots present or absent; sterna pale yellowish.

MALE (Fig. 19). Palpus, proboscis and antenna as described and figured by Colless (1965: 270); sexual dimorphism well developed, particularly in the presence of numerous fine setae, forming a dense patch on anterior part of fossa of the mesonotum. *Palpus*. Relatively long, exceeding proboscis by nearly the combined length of segments 4 and 5; basal fingerlike processes distinct, about 0.5 of the distal part of segment 1; segment 3 with a ventral row of short tiny setae which are dense in basal 0.5, sparse in apical 0.5; ventral lateral tuft of setae not developed or absent; apical 0.2 with 5-10 dark bristles; segments 4 and 5 strongly plumose. *Proboscis*. Dorsal upright setae present, extending from basal 0.25 to apex of labium, their length 3 times as long as labial width at point of insertion. *Antenna*. F-5 with a large prominent fan-shaped tuft of 7-10 dark broad apically blunt scales which are as long as the combined length of the next 4 flagellomeres, followed laterally and ventrally by 10-12 distally pale flattened setae of subequal length; F-6, 7 with dark crumpled tufts of curled setae as described for *cinctellus* and other preceding species; mesal tuft of F-7 rather thick, with 6, 7 subapically twisted setae; J-hooked tuft of F-8 with characteristic twist or kink subapically; F-9 with 5 yellowish bladelike scales; F-10 with 2, 3 strong bristlelike setae.

MALE GENITALIA (Fig. 19). Essentially as described and figured by Colless (1965: 271) and Bram (1967a: 74). *Segment IX*. Tergal lobe small, bearing 4-6 weak setae; sternum without any scales or setae towards caudal margin. *Basimere*. Normal, with a row of 3 moderately long submarginal setae on slight convex inner tergal surface; 4, 5 marginal setae strong, 0.50-0.75 of submarginals. *Subapical Lobe*. Rodlike setae *a-c* stout, subequal, smoothly curved; setae *d-f* 5 in number; leaflet g_2 broad club-shaped, apex pointed or blunt; leaflet g_1 rather narrow, short, with acute apex; seta *h* moderately long. *Distimere*. Normal; subapical dorsal surface lightly annulated; subapical claw short, more or less dilated apically; ventral tiny seta longer than dorsal. *Phallosome*. Apical beaklike process slender, long, sustaining about 90 degrees with main stem and distally tapered into a sharp point. *Proctiger*. Crown small, consisting of 3, 4 coarse spicules laterally and several spinelike spicules internally; paraproct with a small apical lateral lobe and a broad round apical sternal lobe; cercal setae 3.

PUPA (Fig. 19). Abdomen: 2.5 mm. Paddle: 0.65 mm. Trumpet: 0.72-0.75; index 11-12. Pigmentation variable, usually yellowish white or sometimes with indefinite brownish areas on cephalothorax and metanotum. *Trumpet*. Relatively long, darker than underlying integument, meatus slightly swollen in middle, narrow towards basal and apical portions, pinna narrow, with slit extended to meatus. *Cephalothorax*. Seta 1-C usually triple (2-4); 3-C triple; 5-C usually 4 branched; 8-C single or double; 9-C usually double (2-3). *Metanotum*. Setae 10, 11-C double. *Abdomen*. Seta 5-IV 4-7 branched; 5-V usually 4 branched (3-5); 5-VI double; 6-III-VI usually 4 branched (3-4); 9-VII usually triple (2-4); 4-VIII usually triple (2-3); 9-VIII as long as 9-VII, usually 7 branched (5-8). *Paddle*. Broad, inner part lightly darkened, outer part pale except for darkened area along midrib, midrib strong and usually

very dark.

LARVA (Fig. 20). Head: 0.72 mm. Siphon: 1.6-1.9 mm; index 7-10. Saddle: 0.36 mm; siphon/saddle ratio 5. Essentially conforms to the group, with the following diagnostic features. *Head*. Seta 4-C distally forked into 2-4 branches, its length about 0.5 of the distance between bases of the pair; 5, 6-C double; 10-C 3, 4 branched; 14-C double. *Thorax*. Lightly to moderately spiculated, spicules distinct under 10X objective, seta 3-P usually double (1-2); 4-P double; 7-P triple; 8-P double; 14-P single. *Abdomen*. Unspiculated; seta 7-I double; 6-III 3, 4 branched; 6-IV-VI usually 4 branched (4-5). Comb scales normal, 40-50. Saddle lightly spiculated on posterior caudal margin; seta 2-X 3, 4 branched; anal gills as long as saddle length. *Siphon*. Slender, long; median dark band present or absent; pecten teeth 9-14, distal teeth with about 10 graded denticles; subventral tufts weak, rather inconspicuous, 4 pairs, each tuft double or triple, as long as siphonal width at point of attachment; 2-S fine, hairlike; median caudal filament of spiracular apparatus well developed.

TYPE-DATA. Lectotype ♂*, Kuala Lumpur, [*Selangor*], *Malaya* [MALAYSIA], marshy ground, Circular Road, October 19, 1903, G. F. Leicester (BM NH; selection of Colless 1965: 270).

DISTRIBUTION. Thailand, Vietnam and Malaysia; also reported from India and Hainan (China), but not known from the Philippines; 151 specimens examined: 88♂, 30♀, 33 L; 48 with associated immature skins (17 p, 31 lp).

THAILAND. *Bangkok; Thon Buri:* Bangkok Noi; *Trat:* Koh Chang; Ban Salak Phet; *Chanthaburi:* Ban Si Phraya; Ban Wak; Ban Sung Bon; *Ranong:* Kraburi; *Songkhla:* Boripat Waterfall; *Satun:* Muang; *Narathiwat:* Ba Chau Village; Ban Tone; 18♂, 16♀, 28 L, 11 p, 20 lp.

VIETNAM. Vung Tau; 1 L.

MALAYSIA. *Peninsular Malaysia - Selangor*: Rantau Penjang; Kuala Lumpur; *Pahang:* Bentong Rd.; Tungku K. Lipis; Bt. Betong K. Lipis; Mela K. Lipis; *Perak:* Kg. Kuala Dipang; Kuala Kangsar; *Johore:* Kota Tinggi; *Perlis:* Kg. Gunong; *Kedah:* Sintok, F. R.; *Trengganu:* Marang; 21♂, 5♀, 4 L, 3 p, 4 pl. *Malaysia - Sabah:* Lipasar Papar; N. Sandakan; Papar; Beaufort; Sandakan Bay; Kota Kinabalu; Tawau; 49♂, 9♀, 3 p, 7 lp.

Additional records from the literature: INDIA: Assam; Andaman Is. (Barraud 1934: 370, as *fraudatrix*); CHINA: Hainan Island (Chu 1957: 163, as *fraudatrix*); INDONESIA: Sumatra; Java, Borneo (Brug and Bonne-Wepster 1947: 186, as *fraudator*, in part); MALAYSIA: Sarawak; SINGAPORE: Johore (Colless 1965: 273).

TAXONOMIC DISCUSSION. The adults of *variatus* are variable in coloration. In Malaysia, the adults are locally differentiated into the pale inland form and the dark coastal form, as pointed out by Colless (1965: 273). The pupa and larva are also variable in the color of the integument, more or less correlated with their adults. However, as there are no significant correlated differences in the male characters, including the genitalia and the diagnostic pupal and larval chaetotaxy, it is probable that only a single species is involved and that these variations are environmentally induced.

The female of *variatus* is difficult to separate from most members of the *Fraudatrix* Subgroup but the male, pupa and larva are distinctive and can be readily recognized by the characters as given in the keys and as described above. One of the most diagnostic features of the *variatus* male not described before, is the presence of several fine hairlike setae laterad of the dorsocentral bristles on the anterior surface of the fossa. This character provides a clear cut separation of the *variatus* males from all sympatric forms in the *variatus* complex.

Until it was resurrected by Colless (1965), *variatus* had been considered by several authors as synonymous with *fraudatrix* Theobald from New Guinea. The relationships between *variatus* and the typical *fraudatrix* as well as among the members of these 2 complexes are extremely close and all may well be assigned to the same complex as suggested by Sirivanakarn (1968: 155-6).

BIONOMICS. *Culex variatus* utilizes various types of ground pools as breeding habitats, including: puddles, ditches, ponds, marshy depressions, swamps under partial or heavy shade of forest or nipa palms. In Malaysia, the larvae were reported to be most common in stagnant, usually fresh water, partly shaded ground pools containing much organic matter in nipa palm swamp. They were sometimes collected from palm axils, tins, cavities in fallen logs or bamboos and crab holes (Colless 1965). The adults have been collected from rearing the larvae, but several were also collected by light traps and by sweeping with nets. The dark adult form readily attacks man by day under forst cover in certain areas but its normal hosts are probably birds or forest mammals (Colless 1965).

17. *CULEX (LOPHOCERAOMYIA) JOSEPHINAE* BAISAS
(Fig. 21)

Culex (Lophoceratomyia) josephinae Baisas 1935: 172 (♂*, ♀).
Culex (Lophoceraomyia) fraudatrix Theobald, Bohart 1945: 74 (taxonomy); Stone, Knight and Starcke 1959: 233 (catalog).
Culex (Lophoceraomyia) josephinae Baisas, Delfinado 1966: 106 (♂*).

FEMALE. Exceedingly similar to the pale form of *variatus* and is essentially as described for the latter, differing slightly in having predominantly pale broad decumbent scales and more numerous yellowish brown narrow decumbent scales on the vertex of head. *Cibarial Armature* (Fig. 21). Essentially similar to *variatus* from which it is indistinguishable.

MALE. Extremely similar to *variatus* in palpal, proboscis and antennal characters, differing slightly in having less numerous fine hairlike setae on anterior surface of fossa.

MALE GENITALIA (Fig. 21). As figured and described by Baisas (1935: 172-3) and Delfinado (1966: 106-7); exceedingly similar to *variatus* in the details of basimere and distimere, differing from it particularly in the following. *Subapical Lobe*. Leaflet g_1 of distal part markedly reduced to a narrow, acute, bladelike seta. *Phallosome*. Apical dorsal beaklike process very stout, short, strongly bent downwards, sustaining an acute angle with the main stem, its posterior apical margin provided with a number of minute spicules. *Proctiger*. Paraproct with poorly developed apical lateral lobe; apical sternal lobe broad and rounded; cercal setae usually 2 in number.

PUPA. As described and figured for *variatus* (Fig. 19) from which it is indistinguishable.

LARVA. As described and figured for *variatus* (Fig. 20) from which it differs slightly in the following features. *Head*. Antennal shaft with weaker and finer spicules in basal 0.5. *Thorax*. Spiculation practically absent; seta 3-P always single. *Siphon*. Uniformly yellowish white, median dark ring absent.

TYPE-DATA. Types ♂, ♀ (lost), Del Carmen, Pampanga Province, *Luzon*, PHILIPPINES, larva breeds in a clear vegetated river slew, March 6, 1930, F. E. Baisas (Bureau of Health, Manila; the types were probably destroyed

during World War II).

DISTRIBUTION. Known only from the Philippines; 92 specimens examined: 71♂, 20♀, 1 L; 2 with associated immature skins (2 lp).

PHILIPPINES. *Mindoro:* San Jose; *Samar:* Osmena; *Leyte:* San Rosa; Tacloban; Diit, Lago Lago, Bay Bay; Dagamit, Mt. Lobi; *Mindanao:* Parang, Ludlow Barracks; Kabakan; Zamboanga; Paranonco; Agusan, S. Francisco; Surigao, S. Francisco; 71♂, 20♀, 1 L, 2 lp.

TAXONOMIC DISCUSSION. *Culex josephinae* is restricted to the Philippines where it is one of the most common forms of *Lophoceraomyia.* It is probably widespread throughout the area, including several small and large islands. The phallosome and a few other characters of the male genitalia of *josephinae* as given above are remarkably constant, providing a clear-cut separation from those of *variatus*. It is possible that *josephinae* is only subspecifically distinct from *variatus*, but, as there is no overlap in the diagnostic features of the male genitalia between the 2 forms, it appears most practical to provisionally recognize both as full species.

BIONOMICS. *Culex josephinae* is a typical ground pool breeder, as in *variatus*. The recorded breeding sites include marshes and swamps associated with stands of nipa palm and forests in coastal areas. Several adults were collected while resting on vegetation by sweeping with a net as well as from mass rearings in the field. Nothing is known about the adult biology and its medical importance.

18. *CULEX (LOPHOCERAOMYIA) CUBITATUS* COLLESS
(Fig. 21)

Culex (Lophoceraomyia) cubitatus Colless 1965: 273 (♂*, ♀, L*); Sirivanakarn 1973: 215 (distribution).

FEMALE. Wing: 3.0 mm. Forefemur: 1.5 mm. Proboscis: 1.9 mm. Medium-sized, brownish species, essentially as described for *variatus*, differing from it slightly in the following characters. *Head.* Broad decumbent scales of vertex predominantly pale, forming a distinct ocular line; narrow decumbent scales in the center more numerous. *Cibarial Armature.* As in Fig. 21. *Abdomen.* Terga II-VII with lateral pale scaling, more or less contrast with dark scaled areas on dorsal surface.

MALE (Fig. 21). As described by Colless (1965: 273-4), differing from *variatus* particularly in the following features. *Proboscis.* Dorsal upright setae stronger and more numerous; lateral and ventral surface of labium with several distinct setae (largely absent in *variatus*). *Antenna.* Modified tuft of F-5 larger, composed of 14-18 broad, dark, blunt tipped scales in dorsal group, followed laterally and ventrally by about 10 pale, hairlike setae which are gradually increased in length; F-8 with smoothly curved J-hooked tuft; F-9 with 5 darker and broader bladelike scales. *Thorax.* Anterior surface of fossa without a dense patch of fine hairlike setae laterad of dorsocentral bristles.

MALE GENITALIA (Fig. 21). Extremely similar to *variatus*, differing from it particularly in the following. *Basimere.* Inner tergal surface usually with a row of 4 submarginal setae, sometimes 3 or 5. *Subapical Lobe.* One of the 3 proximal rodlike setae in group *a-c* strongly angulate, or with a characteristic elbow beyond middle. *Phallosome.* Apical dorsal beaklike process stouter, shorter, distally tapered into a blunt apex. *Proctiger.* Crown larger, with more numerous spicules; paraproct with short, broadly rounded apical lateral

and sternal lobes.

PUPA. Abdomen: 2.4 mm. Paddle: 0.65 mm. Trumpet: 0.63 mm; index 10-12. As figured and as described for *variatus*, differing from it in the following characters. *Trumpet*. Rather thicker, shorter, darker and strongly curved in middle. *Cephalothorax*. Seta 5-C 5 branched; 8-C double, much stronger and longer than 9-C. *Abdomen*. Seta 5-IV 4, 5 branched; 5-V, VI double; 6-III-V usually double (1-3); 6-VI triple. *Paddle*. Midrib moderately to strongly infuscated, inner and outer parts of paddle pale.

LARVA. Head: 0.70 mm. Siphon: 1.7-2.0 mm; index 9-11. Saddle: 0.35 mm; siphon/saddle ratio 4. As figured for *variatus* from which it differs chiefly in the following features. *Head*. Seta 4-C shorter; 10-C single or double. Antenna shaft darker, with stronger spicules. *Thorax*. Spiculation absent or not developed; seta 14-P usually double, rarely single. *Abdomen*. Seta 6-III usually triple. Comb scales apparently fewer, about 23-40 (average 30). Saddle seta 2-X double. *Siphon*. Rather longer, thinner, uniformly yellowish white or brown; median dark ring absent.

TYPE-DATA. Holotype ♂ (57/48/1) with associated pupal and larval skins, slides of antenna (CH 118) and genitalia (CT 474), Mandai Road, SINGAPORE, December 29, 1957, D. H. Colless (ANIC).

DISTRIBUTION. Singapore, Malaysia, the Philippines (Mindanao), Ceram, Indonesia and Papua New Guinea; 40 specimens examined: 17♂, 5♀, 18 L; 6 with associated immature skins (2 p, 4 lp).

SINGAPORE. Mandai Road (type-locality); Mc Ritchie Reservoir; 3♂ (including holotype), 1♀, 13 L, 3 lp.

MALAYSIA. *Peninsular Malaysia - Pahang:* Cameron Highlands; 4 L. *Sabah:* Tawau; Papar; Beaufort; 7♂, 2♀, 1 L, 2 p, 1 lp.

PHILIPPINES. *Palawan:* Princesca; Mindanao: Agusan, S. Francisco; 5♂, 2♀.

INDONESIA. Ceram; 1♂.

PAPUA NEW GUINEA. Sepik: Vanimo; 1♂.

TAXONOMIC DISCUSSION. *Culex cubitatus* is differentiated from *variatus* and other members of the *variatus* complex by the combination of the male characters, larval and pupal chaetotaxy as described above. This species has been seldom encountered but apparently exhibits a very broad range of distribution, extending into the Philippines (Mindanao), Ceram and New Guinea (Sirivanakarn 1973: 215). In Singapore, Colless (1965: 274) noted that *cubitatus* is sympatric with the dark form of *variatus*, but occupies a distinct ecological niche, restricted to the inland areas, similar to the pale form of *variatus* in Malaysia. Those facts are well supported by the recent collections in Malaysia.

BIONOMICS. In Singapore, *cubitatus* was found breeding in jungle ground pools away from the tidal zone or coastal areas (Colless 1965). In Peninsular Malaysia, the *cubitatus* larvae were collected from a pool at a high elevation in the Cameron Highlands. The adults from Sabah, Malaysia were collected by a sweep net and by rearing the pupae and larvae. The adults recorded elsewhere all apparently came from general field catches by sweeping with nets. Nothing is known about the biology or medical importance of the adults.

19. *CULEX (LOPHOCERAOMYIA) GRACICORNIS* NEW SPECIES
(Fig. 22)

Culex (Lophoceraomyia) sp. near *cubitatus* Colless 1965: 274 (♂*, ♀).

FEMALE. Unknown.

MALE (Fig. 22). As described and figured by Colless (1965: 274-5); essentially similar to *cubitatus* in palpal, labial and antennal characters, differing from it chiefly in the following. *Palpus*. Segments 4 and 5 more strongly plumose. *Thorax*. Dorsocentral bristles relatively weaker; 2, 3 rows of several short, fine setae laterad of anterior dorsocentrals present, extending to middle of fossa (absent or only a few present in *cubitatus*).

MALE GENITALIA (Fig. 22). As figured; exceedingly similar to *cubitatus*, differing from it particularly in the following. *Basimere*. Inner tergal surface with only 3 submarginal setae in a row. *Subapical Lobe*. Rodlike setae *a-c* smoothly curved, seta *c* (or external rod of Colless) not angulate or without a distinct elbow beyond the middle. *Phallosome*. Apical dorsal beaklike process slender, relatively longer and distally tapered into a sharp point. *Proctiger*. Paraproct with an elongate budlike apical lateral lobe which is apically blunt or pointed, apical sternal lobe broadly rounded.

PUPA and LARVA. Unknown.

TYPE-DATA. Holotype ♂ with slides of antenna (CH 122) and genitalia (CT 524), Ayer Mati, *Perak*? MALAYSIA (ANIC). Paratype 1♂ with slides of antenna (CH 123) and genitalia (CT 523), same data as holotype (ANIC).

DISTRIBUTION. Known only from Thailand and Peninsular Malaysia. Specimens examined: 4♂.

THAILAND. *Chiang Mai:* Chang Puak; *Kanchanaburi:* Ban Sai Yok; 2♂.

MALAYSIA. *Peninsular Malaysia - Perak*?: Ayer Mati; 2♂.

TAXONOMIC DISCUSSION. *Culex gracicornis* is morphologically intermediated between *cubitatus* and *variatus*. The male, the only known stage of *gracicornis*, is very similar to *cubitatus* in the details of the modified tufts of antennal flagellomeres 5-10, but its genitalia are similar to *variatus* in the phallosome and in the rodlike setae of the subapical lobe. This species was previously described by Colless (1965: 274) as sp. near *cubitatus* based on 2 males from Malaya. In this study, 2 other males were also discovered among the Thailand material, which on the basis of close comparison, perfectly agree with the Malayan specimens. Based on these records, I am convinced that *gracicornis* is distinct and should be properly recognized as a separate species within the *variatus* complex.

BIONOMICS. The type-males of *gracicornis* apparently came from a general field collection. In Thailand, the male from Kanchanaburi was obtained from rearing an immature collected from a pool on the flooded ground in an unshaded area near a native plantation and the other from Chiang Mai presumably came from a light trap.

20. *CULEX (LOPHOCERAOMYIA) WHARTONI* COLLESS
(Fig. 22)

Culex (Lophoceraomyia) whartoni Colless 1965: 275 (♂*, ♀, L*).

FEMALE. Wing: 3.0 mm. Forefemur: 1.4 mm. Proboscis: 1.7 mm. In general exceedingly similar to the dark form of *variatus*, slightly differing from it in the following. *Head*. Broad decumbent scales of vertex entirely dark; narrow decumbent scales sparse, yellowish brown, restricted to dorsal midline in center; lateral patch of broad scales dark. *Cibarial Armature* (Fig. 22). Cibarial bar with about 40 teeth in a concave row which is more or less produced in middle. *Thorax*. Mesonotal integument deep chestnut brown;

mesonotal scales entirely blackish. *Ppn* with several narrow, short, dark scales or setae cephalad of posterior bristles. *Wing*. Plume scales on R_2, R_3 relatively broader. *Abdomen*. Terga II-VII usually with basolateral pale spots; sterna slightly paler or as dark as terga.

MALE (Fig. 22). As described and figured by Colless (1965: 275-6); generally dark or blackish as in female; differing from *variatus* and other related forms particularly in the following. *Palpus*. Basal fingerlike processes relatively long, reaching apex of segment 1. *Proboscis*. Labium with fewer and weaker dorsal upright setae; lateral setae practically absent. *Antenna*. Modified tuft of F-5 very prominent, distinct in shape, composed of 16-22 broad scales only, 10-16 scales in dorsal group longest, black, apically blunt or abruptly pointed, followed by lateral group of 5, 6 distally pale or entirely dark curved, sharply pointed scales of decreasing length; F-8 with a typical or normal J-hooked tuft of fused setae, as *cubitatus*. *Thorax*. Anterior surface of fossa without a dense group of fine hairs laterad of dorsocentral bristles.

MALE GENITALIA (Fig. 22). Exceedingly similar to *cubitatus*, *variatus* and *gracicornis*, differing slightly in the following features. *Basimere*. Submarginal setae usually 4 in number. *Subapical Lobe*. All rodlike setae *a-c* smoothly curved in distal portion; leaflet g_1 relatively broad, as long as or longer than leaflet g_2. *Phallosome*. Paraproct with a distinct apical lateral lobe which is apically rounded.

PUPA. Abdomen: 2.5 mm. Paddle: 0.65 mm. Trumpet: 0.65 mm; index 10. As figured for *variatus* (Fig. 19) and essentially similar to the latter in coloration of cephalothorax, abdomen and paddle and in the shape of trumpet, differing in the following. *Trumpet*. Shorter, with lower index. *Cephalothorax*. Seta 8-C usually single (1-2) and rather weak. *Abdomen*. Seta 1-II weakly dendritic or with smaller number of branches; 5-IV 3, 4 branched; 5-V, VI double; 6-III-VI usually double (1-2); 4-VIII usually double (2-3).

LARVA. Head: 0.76 mm. Siphon: 1.5 mm; index 8. Saddle: 0.3 mm; siphon/saddle 5. As figured for *variatus* (Fig. 20), very similar to the latter in most chaetotaxy, differing particularly in the following. *Head*. Seta 4-C longer, as long as or longer than distance between bases of the pair; 16, 17-C rather inconspicuous or sometimes absent. *Thorax*. Spiculation lighter; seta 3-P 3, 4 branched, sometimes more; seta 1-M very strong, as long as or longer than 3-M; 1-T as long as 2-T. *Abdomen*. Seta 6-III 4, 5 branched. Comb scales 28-36. Seta 2-X of saddle usually triple (3-4). *Siphon*. Rather shorter, thicker; median dark ring usually present; subventral tufts stronger, more conspicuous, usually 3, 4 branched (2-4) each.

TYPE-DATA. Holotype ♂ with associated pupal and larval skins, slides of antenna and genitalia, SINGAPORE, reared from a single egg raft (SS 115), June 22, '56, D. H. Colless (ANIC).

DISTRIBUTION. Thailand, Malaysia, Singapore and Indonesia; 125 specimens examined: 56♂, 42♀, 27 L; 27 with associated immature skins (2 p, 25 lp).

THAILAND. *Narathiwat:* Koh Kien; 1♂.

MALAYSIA. *Peninsular Malaysia - Selangor:* Banting; Bt. Ulu Bakau; 9♂, 10♀, 6 lp. *Malaysia* (N. Borneo) - *Sabah:* Tawau; Beaufort; 36♂, 27♀, 27 L, 2 p, 17 lp.

SINGAPORE. McRitchie Reservoir; Mandai Road; Nee Soon Rifle Range; 8♂, 5♀, 2 lp.

INDONESIA. *Sumatra:* Benkoelen, Dermajoe; Achin, Kutaraja; 2♂.

TAXONOMIC DISCUSSION. The adults of *whartoni* are apparently darker

than *variatus* and *cubitatus* and can generally be separated from the latter 2 species in the female by the dark broad scales on dorsal and lateral surfaces of the vertex and the deep brown or black mesonotum and pleuron. The female cibarial armature is also distinctive in having the concave row of teeth produced in the middle, quite different from those as described for *variatus* and other species in the *Fraudatrix* Subgroup. The male can be readily separated from the other members of the *variatus* complex by the modified tuft of antennal flagellomere 5; the fewer and shorter dorsal upright setae of the proboscis and by the relatively longer basal fingerlike processes of the palpus. The male genitalia resembles *cubitatus* more than any other species, but can be separated from it by the smoothly curved rodlike setae *a*-*c* and broader leaflet g_1 of the subapical lobe. Both pupa and larva of *whartoni* are very distinct in the diagnostic chaetotaxy given above and can be readily separated from *variatus* and *cubitatus* as indicated in the keys. All specimens of *whartoni* essentially conform to a single type and there is no indication of local differentiation in the material I have examined. Evidence from comparative male morphology indicates that it is closer to *cubitatus* than to *variatus*.

BIONOMICS. *Culex whartoni* is less common than *variatus* but has been more frequently encountered than *cubitatus* in the collections from Malaysia and Singapore. The reported breeding sites are ground pools, ditches and swamps along the seacoast under deep shade of jungle or in the open near forests. In Selangor, it was reported to prefer acid peaty soils as a breeding site (Colless 1965). Most of the adults were obtained from individual or mass rearings from the larvae and pupae but, some were also taken while resting near its breeding sites.

21. *CULEX (LOPHOCERAOMYIA) MACDONALDI* COLLESS
(Figs. 23, 24)

Culex (Lophoceraomyia) macdonaldi Colless 1965: 276 (♂*, ♀, L*); Delfinado 1966: 108 (2*, P*, L*); Bram 1967a: 61 (♂*, L*).

FEMALE. Wing: 2.3-2.8 mm (average 2.6 mm). Forefemur: 1.25 mm. Proboscis: 1.6 mm. In general resembling other members of the *variatus* complex, differing in smaller size and in the following characters. *Head*. Broad decumbent scales of vertex entirely dark; erect scales slender; lateral patch of broad scales bluish white, distinct. Palpus and proboscis slender. *Cibarial Armature* (Fig. 23). Cibarial bar with a concave row of about 30 teeth, median 4-6 teeth shorter and thinner than lateral teeth. *Thorax*. Mesonotal integument reddish brown (field caught specimens) to dark, blackish (reared specimens); mesonotal scales narrow, blackish. *Ppn* with a few narrow dark scales cephalad of posterior bristles. Pleuron same color as mesonotum. *Legs*. Relatively slender; anterior surface of hindfemur largely pale whitish in basal 0.5, dark in apical 0.5. *Wing*. Plume scales on R_2, R_3 moderately broad clavate. *Abdomen*. Terga III-VII always with large basolateral pale spots, from base to over 0.5 of segment; sterna nearly as dark as dorsal surface of terga.

MALE (Fig. 23). As described by Colless (1965: 276-7); in general similar to female except for the absence of basolateral pale spots on the abdominal terga, differing from other members of the *variatus* complex in the following. *Palpus*. Slender; basal fingerlike processes strong and relatively long, projecting beyond apex of segment 1; segments 4 and 5 moderately plumose. *Pro-*

boscis. Dorsal upright setae numerous and dense, extending from basal 0.25 to apex of labium; labial basal bristles relatively long, weak, hairlike. *Antenna*. Modified tuft of F-5 distinctive, composed of 16-20 scales, 8-10 scales in dorsal group dark, broad, blunt tipped, followed by lateral group of 6-10 scales which are broad and dark at base, distally narrow, pale and wavy in outline; F-8 with a typical J-hooked tuft of fused setae; F-9 with 4, 5 yellowish brown to dark blade-like scales; F-10 with 3-5 dark bristlelike setae.

MALE GENITALIA (Fig. 23). As described and figured by Colless (1965: 276-7) and Bram (1967a: 62-3), differing from other members of the *variatus* complex in the following features. *Basimere*. Slender and relatively small; inner tergal surface evenly concave, with a linear row of 4 submarginal setae, sometimes 3 or 5; marginal setae very weak and sparse. *Subapical Lobe*. Rods *a-c* thin, smoothly curved, proximally completely overlapped from base to beyond 0.5 of the length, distally more or less separated; setae *d-f* in distal part 3; leaflets g_1, g_2 broad, subequally long; seta *h* moderate. *Distimere*. More or less swollen beyond middle, distally tapered into a blunt point; subapical claw slender and short. *Phallosome*. Apical dorsal beaklike process very slender, short and weakly sclerotized. *Proctiger*. Crown rather small; apex of paraproct broadly rounded, without differentiated apical lateral and sternal lobes; cercal setae 2, 3, minute and rather inconspicuous.

PUPA (Fig. 23). Abdomen: 2.2 mm. Paddle: 0.6 mm. Trumpet: 0.62 mm; index 9-10. Generally yellowish white, with indefinite darkened area; distinguished from other members of the *variatus* complex by the following features. *Trumpet*. Slender; meatus uniformly cylindrical from base to 0.75 of length; apical 0.25 more or less swollen; pinna rather broad and long, without slit extending to meatus. *Cephalothorax*. Posterior margin of mid-dorsal ridge dorsad of base of trumpet strongly folded and very irregular; setae 8, 9-C double. *Abdomen*. Seta 5-IV 5-8 branched; 5-V usually 4 branched (3-5); 6-III-V usually triple (2-3); 6-V usually double (2-3). *Paddle*. Inner and outer parts pale except for darkened area along midrib and apex, midrib very strong and dark.

LARVA (Fig. 24). Head: 0.70 mm. Siphon: 1.4 mm; index 8. Saddle: 0.3 mm; siphon/saddle ratio 4-5. As described by Colless (1965: 277), the following characters are diagnostic. *Head*. Seta 4-C very short, minute, less than 0.5 of the distance between bases of the pair; 9-C strong, 2-3 times as long as 8-C, located near base of antennal prominence cephalad of 8-C; 14-C 3, 4 branched. Antennal shaft largely pale, with relatively few and weak spicules. *Thorax*. Spiculation absent; seta 3-P 3, 4 branched, sometimes double. *Abdomen*. Setae 6-III-VI 4, 5 branched. Comb scales 37-44, scales on posterior row elongate, twice as long as scales on anterior row, middle scales intermediate; apical fringe normal. Saddle same color as siphon; seta 2-X 4 branched; 4-X with 6 pairs of branched setae, sometimes 4.5-5. *Siphon*. Slender, moderately long and usually yellowish white; distal pecten teeth with 1, 2 strong basal denticles and 7-9 graded denticles distally; subventral tufts weak, short, 3, 4 branched each, as long as or slightly longer than siphonal width at points of attachment.

TYPE-DATA. Holotype ♂ (56/33/11) with associated pupal and larval skins, slides of antenna (CH9) and genitalia (CT 301), SINGAPORE, March 26, 1956, D. H. Colless (ANIC).

DISTRIBUTION. Thailand, Vietnam, Malaysia, Singapore, Indonesia and the Philippines; also reported from India. 62 specimens examined: 36♂, 17♀, 9 L; 13 with associated immature skins (3 p, 10 lp).

THAILAND. *Sakon Nakhon; Bangkok:* Bang Khen; Bang Kapi; *Thon Buri:*

Bangkok Noi; *Chon Buri:* Sri Racha; Bang Lamung; *Chanthaburi:* Ban Si Phraya; *Phangnga:* Khao Sung; *Narathiwat:* Kok Kien; Ban Tone; 13♂, 3♀, 7 L, 1 p, 4 lp.

VIETNAM. Conson; Pleiku; Kontum; 13♂, 1 lp.

MALAYSIA. *Peninsular Malaysia - Pahang:* Tioman; *Perak:* Trong; 4♂, 14♀, 2 p, 3 lp; *Malaysia - Sabah:* Beaufort; 2 L.

SINGAPORE. 3♂, 1 lp.

INDONESIA. *Sumatra:* Bengkoelen, Dermajoe; 1♂.

PHILIPPINES. *Mindoro:* San Jose; 2♂, 1 lp.

Additional records from the literature: INDIA. Assam: Golaghat (Colless 1965: 277).

TAXONOMIC DISCUSSION. The modified tuft of antennal flagellomere 5 in the male of *macdonaldi* is superficially similar to *variatus*, *cubitatus* and *whartoni* but is quite different from these species in the details as described and illustrated. There is a strong resemblance in this character between *macdonaldi* and the typical *fraudatrix* from the Papuan subregion, which I have also examined for comparison. All stages of *macdonaldi* except the females can be readily separated from the rest of the *variatus* complex as indicated in the keys and as described above. The females are extremely similar to *whartoni* and *inculus* as pointed out by Colless (1965: 277) but appears to be distinct from the latter 2 species in the details of the cibarial armature.

Culex macdonaldi as interpreted here is exclusive of the "Gunong Tebu form" of Colless (1965: 277). The latter was previously assigned to *macdonaldi* by this author, but present study has shown that it is distinct from it in the adult, male genitalia and larval stage as described below under *pairoji*.

BIONOMICS. The breeding sites of *macdonaldi* are restricted to shaded fresh water ground pools in marsh or swamps near tidal zones at sea level along the coast (Colless 1965). Several adults have been collected while resting among vegetation near the breeding sites and only a few from light traps.

22. *CULEX (LOPHOCERAOMYIA) PAIROJI* NEW SPECIES
(Figs. 25, 26)

Culex (Lophoceraomyia) macdonaldi (Gunong Tebu form), Colless 1965: 276 (♂, ♀).

FEMALE. As described for *macdonaldi*, differing from it particularly in the following features. *Head*. Lateral patch of broad scales of vertex pale brown to nearly white, very distinct. *Cibarial Armature*. Cibarial teeth longer, more numerous, 50-60, all subequal in length and size. *Thorax*. Mesonotal disc with acrostichal bristles extending from anterior promontory to the level of wing base. *Wing*. Plume scales on R_2, R_3 relatively broader.

MALE (Fig. 25). As in female; almost identical to *macdonaldi* in the details of palpal, labial and antennal characters, differing from it in the presence of acrostichal bristles on mesonotal disc and in having longer dorsal upright setae on proboscis, the longest ones 4 times as long as labial width at points of insertion.

MALE GENITALIA (Fig. 25). Essentially as described for *macdonaldi*, differing from it particularly in the following. *Basimere*. Inner tergal surface with a prominent row of 6, 7 very strong submarginal setae, somewhat resembling *quadripalpis;* marginal setae stronger, 6-8, about 0.25 of submarginals. *Phallosome*. Apical dorsal beaklike process stouter, darker and well

sclerotized.

PUPA. Essentially as described and figured for *macdonaldi*, differing particularly in the following. *Abdomen*. Seta 5-V usually double, rarely triple or more branched; 4-VIII usually triple or 4 branched. *Paddle*. Inner part lightly to strongly infuscated, outer part pale except for darkened areas along midrib.

LARVA (Fig. 26). Head: 0.7 mm. Siphon: 1.9-2.1 mm; index 10-11. Saddle: 0.36 mm; siphon/saddle ratio 6-7. Extremely similar to *macdonaldi*, differing from it particularly in the following. *Head*. Seta 9-C of the same magnitude as 8-C, located at short distance cephalad of the latter. *Thorax*. Seta 3-P usually double (2-3). *Siphon*. Relatively more slender, with greater index and siphon/saddle ratio, median dark ring usually present; pecten teeth barbed with evenly fine denticles, basal denticles weaker and finer than distal denticles.

TYPE-DATA. Holotype ♂ (SS 32-106) with associated pupal and larval skin and slide of genitalia, Khao Yai National Park, *Nakhon Ratchasima*, THAILAND, deep shaded jungle swamp, 800-900 m, November 1, 1967, S. Sirivanakarn (USNM); Allotype ♀ (SS 32-113) with associated pupal and larval skins; Paratypes: 2 lp♂ (SS 32-110, 111), 3 p♂ (SS 32-100, 101, 112), 5♂ (SS 31, SS 34); 4♀ (SS 28, SS 31, SS 34), same data as holotype (USNM). This species is dedicated to Mr. Pairoj Suwanakorn, Director of Khao Yai National Park, Thailand Ministry of Agriculture.

DISTRIBUTION. Thailand, Malaysia, Singapore and Indonesia. 76 specimens examined: 28♂, 16♀, 32 L; 12 with associated immature skins (4 p, 8 lp).

THAILAND. *Nakhon Ratchasima:* Khao Yai National Park; 21♂, 12♀, 28 L, 3 p, 6 lp.

MALAYSIA. *Peninsular Malaysia - Pahang:* Mela K. Lipis; Benta K. Lipis; *Perak:* C. Highlands Rd.; 2♂, 2♀, 1 L, 1 p; *Malaysia - Sabah:* Tawau; Kota Kinabalu; Beaufort; 2♂, 3 L.

SINGAPORE. McRitchie Reservoir; Nee Soon Rifle Range; 3♂, 2♀.

INDONESIA. *Java:* Surabaja; *Sumatra:* Dermajoe; 2♂.

Additional records from the literature. PENINSULAR MALAYSIA. Trenganu: Gunong Tebu (Colless 1965: 277; as *macdonaldi*).

TAXONOMIC DISCUSSION. The above descriptions of *pairoji* have been based on the study of the specimens from Nakhon Ratchasima, Thailand. The male of *pairoji* apparently agrees well with the "Gunong Tebu form" of *macdonaldi* (Colless 1965: 277). Recently, a number of *pairoji* specimens have also been discovered in Malaya, Singapore and Indonesia, indicating that it is a widespread species. *Culex pairoji* appears to be restricted to high inland elevations in mountainous areas except in Malaya and Singapore where it has also been found along the coast in sympatry with the *macdonaldi* populations.

Culex pairoji is identical to *macdonaldi* in the modified tuft of male antenna, but is distinct from the latter in the adults by the presence of acrostichal bristles on the mesonotal disc and by the presence of a prominent row of 6, 7 strong submarginal setae on the basimere of the male genitalia. The female cibarial armature and the larva are also distinct from *macdonaldi* as indicated in the above description, but the pupa can not be separated from that species with certainty.

BIONOMICS. The immatures and the adults of *pairoji* from the type-locality in Thailand were collected from a large jungle swamp under heavy rain forest shade at an elevation between 800-900 m. The water was fresh, containing numerous algae, fallen leaves and other aquatic vegetation. In Malaya and Singapore, the immatures were collected from pools at the edge of a stream,

swamp and marshy depression from sea level to about 30 m. The adults from Gunong Tebu, Trengganu were collected at a high elevation (Colless 1965). Several adults in Thailand were collected by a sweep net and a sucking tube while resting under leaves of plants near the breeding site. The female does not appear to bite man.

alphus complex

23. *CULEX (LOPHOCERAOMYIA) ALPHUS* COLLESS

(Figs. 27, 28)

Culex (Lophoceraomyia) alphus Colless 1965: 283 (♂*, ♀, L*); Bram 1967a: 53 (♂*, ♀, L*).

FEMALE. Wing: 2.6 mm. Forefemur: 1.3 mm. Proboscis: 1.5 mm. Small, blackish species, with general facies similar to most members of the *Fraudatrix* Subgroup. *Head*. Vertex largely covered with broad, dusky decumbent scales which are pale whitish along upper eye margin, forming a distinct ocular line; narrow decumbent scales sparse, restricted to dorsal midline in center; erect scales very slender. Proboscis with 6 strong labial basal setae which are as long as palpus. *Cibarial Armature* (Fig. 27). As figured; cibarial bar with an even concave row of 50-60 subequal teeth which are apically blunt or truncate. *Thorax*. Mesonotal integument dark brown, scales narrow, blackish. *Ppn* bare on anterior upper surface; posterior bristles 2, 3. Pleuron same color as mesonotum; *ppl* bristles 2; 1 lower *mep* bristle absent. *Legs*. Slender; anterior surface of hindfemur silvery white in basal 0.5, dark in apical 0.5. *Wing*. Scales minute and rather scanty on all veins. *Abdomen*. Terga dark, without basolateral pale spots; sterna yellowish scaled.

MALE (Fig. 27). In general similar to female, with diagnostic features as described and figured by Colless (1965: 283-5). *Palpus*. Rather short, very slender, as long as or slightly longer than proboscis; basal fingerlike processes well developed, as long as the distal part of segment 1; segments 4 and 5 slightly upturned, with several weak and short bristles. *Proboscis*. Slender; dorsal upright seta strong, numerous, extending from 0.25 from base to apex of labium, longest setae 4, 5 times as long as labial width at points of insertion. *Antenna*. Flagellar whorls weakly to moderately plumose; F-5 with a large characteristic tuft of 12-18 dark scales, 6-8 scales in dorsal group longest, blunt or point tipped, as long as the combined length of the next 4 flagellomeres, followed laterally by 2-4, narrower, shorter, pointed scales and ventrally by 3-6, subapically swollen scales of increasing length; F-6, 7 with crumpled tufts of curled setae as described in most forms; F-8 with normal J-hooked tuft; F-9 with 3, 4 yellowish bladelike scales; F-10 with 2-4 dark, strong, bristlelike setae.

MALE GENITALIA (Fig. 27). Rather small; generally similar to the members of the *rubithoracis* and *quadripalpis* complexes, distinctive in the following features. *Segment IX*. Tergal lobe with 2 very strong and long setae; sternum usually bare, sometimes with 1 seta towards caudal margin. *Basimere*. Normal; with a row of 4 strong submarginal setae and a few weak marginal setae on inner tergal surface; lateral tergal surface with a group of several rather strong setae laterad of the submarginals. *Subapical Lobe*. Rodlike setae *a-c* stout, subequal and smoothly curved or straight; setae *d-f* 5-6, rather broad, flattened, bladelike, very distinct; leaflets g_1, g_2 well developed; seta *h* strong.

Phallosome. Apical dorsal beaklike process, short, small, sustaining an acute angle with the main stem. *Proctiger*. Crown small, largely composed of fine, spinelike spicules; paraproct with a small short apical lateral and sternal lobes, the latter apically rounded; cercal setae 3, distinct.

PUPA (Fig. 27). Abdomen: 2.2 mm. Paddle: 0.55 mm. Trumpet: 0.52-0.59 mm; index 8-9. Cephalothorax and abdomen more or less uniformly brownish. *Trumpet*. Uniformly slender, long, darker than underlying integument; pinna broad, with slit extended to meatus. *Cephalothorax*. Seta 8-C double, strong, 2,3 times longer than 9-C; 9-C triple. *Metanotum*. Seta 10-C always single. *Abdomen*. Most setae rather weak and short; seta 5-IV usually triple (3-4); 5-V double; 5-VI single; 6-IV-VI usually triple (2-4); 9-VII double; 4-VIII usually 4 branched (3-5); 9-VIII 4,5 branched. *Paddle*. Inner and outer parts pale except for areas adjacent to midrib, midrib strong and dark.

LARVA (Fig. 28). Head: 0.55 mm. Siphon: 1.1 mm; index 8-9. Saddle: 0.3 mm; siphon/saddle ratio about 4. Relatively small sized; complete chaetotaxy as figured, distinctive in the following. *Head*. Usually brownish; seta 4-C short, forked into 4 branches; 5-C rather short, 0.5-0.7 of length of 6-C, both setae double; 14-C double. *Thorax*. Spiculation absent; seta 3-P 4-7 branched; 4-P double; 14-P single; 1-M 0.5 of 3-M. *Abdomen*. Seta 7-I single; 6-I griple; 6-II double; 6-III triple; 6-IV-VI 4,5 branched. Comb scales about 27, posterior scales elongate, 2,3 times as long as scales on anterior row; apical fringe normal. Saddle seta 2-X usually with 3 short branches and 1 long branch. *Siphon*. Slender, moderately long, uniformly brownish, concolorous with head capsule; pecten teeth characteristic, 9-11 in number all apparently simple or with inconspicuous fringe of extremely fine denticles; subventral tufts short, each 3-5 branched, as long as siphonal width at points of attachment; median caudal filament of spiracular apparatus well developed.

TYPE-DATA. Holotype ♂ (0477/6) with associated pupal and larval skins and slide of genitalia (CT 551), Kg. Sijangkang, *Selangor, Malaya* [MALAYSIA], January 21, 1958, D. H. Colless (ANIC).

DISTRIBUTION. Thailand and Malaysia. 10 specimens examined: 3♂, 3♀, 4 L; 5 with associated immature skins (4 p, 1 lp).

THAILAND. *Narathiwat;* 1♂ (only antenna and genitalia).

MALAYSIA. *Peninsular Malaysia - Selangor;* Kg. Sijangkang (type-locality); Banting; *Trengganu:* Dugun; *Johore:* Kota Tinggi; 1♂, 2♀, 2 L, 3 p; *Malaysia: Sabah:* Kota Kinabalu; Beaufort; 1♂, 1♀, 2 L, 1 p, 1 lp.

Additional records from the literature. SINGAPORE (Colless 1965: 285).

TAXONOMIC DISCUSSION. *Culex alphus* can generally be distinguished from the other members of the *Fraudatrix* Subgroup in all stages by the relatively small size; in the females by the presence of 6 long labial basal setae of the proboscis (usually 2 in all others); the male by the characteristic tuft of antennal flagellomere 5; the male genitalia by the presence of 2 very strong and long setae of tergal lobe of segment IX and by other features of the basimere and the phallosome as described and figured; the pupa by having setae 10-C and 5-VI single and in the larva by the elongate posterior comb scales and the simple or fine denticulated pecten teeth of the siphon.

Culex alphus apparently combines features of the *variatus* and the *rubithoracis* complexes. It resembles the *variatus* complex in the development of the modified tuft of the male antennal flagellomere 5, but its larva is similar to the *rubithoracis* complex in having seta 3-P 4-7 branched and seta 7-I single. The male genitalia is somewhat intermediate between the 2 complexes but is apparently more similar to the *rubithoracis* complex than to the *variatus* complex.

BIONOMICS. *Culex alphus* has been seldom encountered and is apparently rare. The breeding sites are pools, ponds, wells and forest swamps at sea level along the coast. Larvae recorded by Colless (1965: 285) were collected from a shaded well of rather peaty water in association with the specimens of *whartoni*. The adults largely came from rearing the pupae or larvae and a few were collected in the field.

MAMMILIFER GROUP

FEMALE. As described for the subgenus; generally distinguished from the *Fraudatrix* Group by darker coloration, absence of basolateral pale spots or basal pale bands on abdominal terga and by the following features. *Head*. Decumbent scales on dorsal and central areas of vertex largely narrow, clavate or linear; erect scales usually completely dark, sometimes partially pale bronzy or yellowish in center. Proboscis with 4 labial basal setae. *Cibarial Armature*. Cibarial teeth relatively few, varying from 15-40. *Thorax*. Mesonotal integument deep brown to black; scales denser and entirely blackish. Scale patch on pleuron usually absent, sometimes present on *ppl*, upper corner and posterior border of *stp*. *Wing*. All veins with more numerous scales; scales on veins R_2, R_3 narrow, linear. *Abdomen*. Terga entirely dark; basolateral pale spots or basal pale bands absent.

MALE. Essentially similar to female in general external features; distinguished from the *Fraudatrix* Group by the following. *Palpus*. Slender, usually as long as proboscis, sometimes longer or reduced to about 0.50-0.75 of proboscis length; basal fingerlike processes absent; segments 4 and 5 very weakly plumose or with relatively few bristles on lateral and mesal surfaces. *Proboscis*. Labial basal setae weak, hairlike and short; false joint absent or not clearly marked by flexion; dorsal upright setae in distal portion of labium completely absent or not developed. *Antenna*. Pedicel with a very distinct, nipplelike spiculose prominence on inner dorsal surface, sometimes not developed (certain New Guinea forms); modified tufts of scales and setae usually present on F-5-8 or F-5-9, sometimes absent; modified tuft of F-5 usually small, inconspicuous, composed of short, acute setae; sometimes large, distinct, with some broad, acute or blunt tipped scales; F-6 to F-8 usually with similar tufts of dark setae as described for the *Fraudatrix* Group, sometimes reduced or modified; F-9 with or without a tuft of long, bristlelike setae; F-10 without any modified setae.

MALE GENITALIA. *Segment IX*. Sternum usually with a row of strong setae or scales towards posterior caudal margin, rarely absent. *Basimere*. Usually small, conical, sometimes modified; submarginal setae usually well developed, forming a prominent row parallel to tergomesal margin, sometimes absent or not differentiated. *Subapical Lobe*. Varied; all specialized setae and leaflets in proximal and distal parts usually present, well developed, sometimes strongly modified. *Distimere*. Sickle-shaped, usually tapered and recurved towards apex, sometimes apex expanded or modified; subapical portion with or without distinct crest of fine spicules on dorsal surface. *Phallosome*. Dorsal lobe of lateral plate usually with a large, partially denticulate external process and a simple, spinelike internal process; ventral lobe strongly reduced or poorly developed. *Proctiger*. Crown large, composed of several coarse spicules and numerous spinelike spicules; paraproct with a short, rounded apical lateral lobe only; cercal setae usually 3, 4.

PUPA. *Trumpet*. Varied from short, bell-shaped or funnel-shaped, 0.25-

0.40 mm (pitcher plant forms) to long, cylindrical, 0.60-0.80 mm; pinna usually without slit extending to meatus. *Cephalothorax*. Seta 8-C usually 1-3 branched, 9-C usually double, sometimes single or triple. *Metanotum*. Seta 11-C single or double. *Abdomen*. Seta 5-IV 1-3 branched, sometimes 4, 5 branched; 5-V single or double; 5-VI usually single, sometimes double; 6-III-VI usually 1-3 branched; sometimes 4-6 branched; 9-VII usually shorter than 9-VIII. *Paddle*. Outer and inner parts usually pale, midrib weak, pale to strong and pigmented.

LARVA. Varied, depending on types of breeding habitat. In general similar to the *Fraudatrix* Group. *Head*. Usually broader than long, sometimes as long as broad (certain pitcher plant forms); seta 4-C as long as or longer than distance between bases of the pair; 5-C usually double, long, sometimes 3 or more branched and short; 6-C 1-3 branched. Antenna as long as or shorter than head; spicules usually numerous, strong, sometimes reduced to completely absent; seta 1-A large, plumose or sometimes considerably reduced; seta 2, 3-A usually subapical, sometimes apical. *Thorax*. Spiculation usually absent, sometimes present, moderately to strongly developed; seta 3-P usually single; 7-P usually double, rarely single or triple; 8-P single, subequal to 7-P, or sometimes strongly reduced; 14-P usually double, rarely single; 1-M strong, as long as 3-M, sometimes shorter. *Abdomen*. Spiculation same as thorax; live or whole mounted specimens without pattern of dark and light bands; setae 6-I, II usually triple, sometimes double or 4, 5 branched; 7-I usually double, sometimes single; 6-III-VI double or triple. Comb scales numerous, sometimes few, all subequal or differentiated in size; apical fringe normal, rarely modified; seta 2-VIII always single. Saddle usually lightly spiculated on posterior caudal margin, sometimes heavily spiculated. *Siphon*. Usually long, slender as in the *Fraudatrix* Group, sometimes considerably reduced (certain pitcher plant forms); pecten teeth usually 10-15, sometimes few, 2-4; subventral tufts usually strong and prominent, 4 pairs, sometimes 6 to 9; median caudal filament absent or not developed except for certain ground pool forms.

DISCUSSION. The *Mammilifer* Group as interpreted here essentially corresponds to the original group C (*Cyathomyia* or *Mammilifer*) of Edwards (1932: 196) and group B (*Mammilifer* Group) of Colless (1965: 264). In the Oriental region, the group includes all species which exhibit a distinct spiculose prominence on the pedicel of the male antenna. *Culex wilfredi*, previously assigned to this group (Colless 1965: Bram 1967a), is here considered as representing a distinct lineage or group, the *Wilfredi* Group. The *Mammilifer* Group is the most diverse major phyletic line in the subgenus. It exhibits a rather distinctive pattern of distribution, being confined largely to the Indomalayan parts of the Oriental region. Elsewhere, it has been reported only from the Papuan part of the Australasian region where 4 species of 3 subgroups are represented (Sirivanakarn 1968).

On the basis of the breeding sites and the morphology of all stages, the 32 Oriental species of the *Mammilifer* Group recognized in this study fall into 2 well marked subgroups: *Mammilifer* and *Brevipalpus* (or B_1 and B_2 of Colless 1965: 264-5). The *Mammilifer* Subgroup comprises 22 species whose breeding habitats are usually tree holes, bamboos and rock pools or sometimes leaf axils of pandanus and ground pools. The *Brevipalpus* Subgroup contains 10 species whose breeding habitats are exclusively pitcher plants. Although the members of the *Brevipalpus* Subgroup exhibit some overlap with those of the *Mammilifer* Subgroup in male characters, its separation from the latter on the basis of the restricted breeding site and certain features of the male and larval characters, as given by Colless (1965), is apparently justified and is fol-

lowed here.

KEYS TO SUBGROUPS AND SPECIES

FEMALES[1]

1. Cibarial teeth coarse, short, widely spaced, usually 15-25; lower *mep* bristle absent (*Brevipalpus* Subgroup). 7
   Cibarial teeth usually slender, elongate, closely spaced, 30-40; lower *mep* bristle usually present, (except *uniformis*, *bengalensis*, *flavicornis* and *lasiopalpis*) (*Mammilifer* Subgroup). . . . 2

Mammilifer Subgroup

2(1). Lower *mep* bristle absent. *uniformis*, *bengalensis*, *flavicornis* and *lasiopalpis*
   Lower *mep* bristle present. 3

3(2). Vertex with a broad, pale, distinct ocular line; ground pool breeders. 4
   Vertex with or without a narrow, pale, distinct ocular line; breeders in tree holes, bamboos, rock pools or leaf axils. . . . 5

4(3). Cibarial teeth short, coarse, 18 in number. . . . . *pholeter*
   Cibarial teeth elongate, relatively slender, 35 in number. *mammilifer* and *wardi*

5(3). Anterior mesepimeron with a row of 5, 6 weak setae dorsad of lower *mep* bristle. . . . . *lavatae*
   Anterior mesepimeron without above setae. 6

6(5). Relatively small species; wing length usually less than 3.0 mm. *impostor*, *traubi*, *demissus* and *ganapathi* (inseparable, use keys to male, pupa and larva).
   Relatively larger species; wing length usually more than 3.0 mm. *spiculosus*, *minor*, *bicornutus*, *bandoengensis*, *tuberis*, *kunhsi*, *peytoni* and *eukrines* (inseparable, use keys to males, male genitalia, pupae and larvae).

Brevipalpus Subgroup

7(1). Upper corner and posterior border of *stp* with a distinct patch of pale scales (*curtipalpis* complex). . . . . *curtipalpis* and *sumatranus*
   Upper corner and posterior border of *stp* without distinct patch of pale scales. 8

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[1] *incomptus* and *crassicomus* are unknown.

8(7). Erect scales of vertex entirely dark. 9
Erect scales of vertex pale golden or bronzy in center, dark on posterolateral area (*brevipalpus* complex).
brevipalpus, *lucaris*, *eminentia* and *acutipalus* (inseparable, use key to males and male genitalia).

9(8). Relatively small species, wing length not exceeding 3.0 mm; 18-25 cibarial teeth. 10
Relatively large species, wing length more than 3.0 mm; 30 cibarial teeth (*jenseni* complex). . . . . *jenseni*

10(9). Minute species; 18-20 cibarial teeth (*hewitti* complex). . . *hewitti*
Relatively larger species; 23 or 25 cibarial teeth (*navalis* complex).
navalis
and *coerulescens*

MALES AND MALE GENITALIA

1. Palpus as long as or longer than proboscis. 2
Palpus 0.50-0.75 of proboscis length (*Brevipalpus* Subgroup, in part). 26

2(1). Inner tergal surface of basimere with 1, 2 submarginal setae or none; leaflet g_1 of subapical lobe absent or not developed (*Brevipalpus* Subgroup, in part). 24
Inner tergal surface of basimere with 1 or more rows of at least 4 submarginal setae; leaflet g_1 of subapical lobe present, well developed (*Mammilifer* Subgroup). 3

Mammilifer Subgroup

3(2). Palpal segments 2 and 3 with prominent lateral rows of numerous fine hairlike setae. (*flavicornis* complex). 4
Palpal segments 2 and 3 without prominent lateral rows of numerous fine hairlike setae as above. 5

4(3). Basimere large, strongly swollen at base; apex of distimere modified (Fig. 55). . . . . *flavicornis*
Basimere small, slender, normal; apex of distimere not modified (Fig. 57). . . . . *lasiopalpis*

5(4). Antennal flagellomeres without modified tuft of scales or setae (*impostor* complex). . . . . *impostor*
Antennal flagellomeres with modified tufts of scales or setae on at least F-6 to 8. 6

6(5). Internal process of phallosome long, reaching or usually projecting beyond apex of external process; external process with a broad, spiculose or denticulate apical lobe (Figs. 30, 32). 7
Internal process of phallosome shorter, not projecting beyond apex of external process; external process with a smaller, elongate,

spiculose apical lobe sternad (Figs. 39, 43). 12

7(6). Antennal flagellomere 9 without a tuft of modified setae (*traubi* complex). 8
Antennal flagellomere 9 with a tuft of modified bristlelike setae (*mammilifer* complex). 10

8(7). Modified tufts of antennal F-5-7 rudimentary or weakly developed; antennal F-8 with smoothly curved tuft of fused setae (Fig. 32). . . . . *lavatae*
Modified tufts of antennal F-5-7 well developed and distinct; F-8 with sigmoid or J-hooked tuft of fused setae. 9

9(8). Modified tuft of antennal F-5 with some broad, blunt-tipped scales; basimere with a row of 4 submarginal setae (Fig. 32). *uniformis*
Modified tuft of antennal F-5 with narrow, acute scales only; basimere with a row of 6, 7 submarginal setae (Fig. 30). . . . *traubi*

10(7). Palpal segments 4 and 5 shortened, segment 4 about 0. 5 of segment 5. . . . . *wardi*
Palpal segments 4 and 5 normal, subequal in length. 11

11(10). Modified tuft of antennal F-5 with some long, broad, blunt-tipped scales; rod *a* of subapical lobe strongly curved, distally separated from rods *b*, *c* by a wide gap (Fig. 34). . . . . *mammilifer*
Modified tuft of antennal F-5 with short, acute flattened setae only; rod *a* of subapical lobe gently curved, largely overlapping with rods *b* and *c* (Fig. 37). . . . . *demissus*

12(6). Antennal F-9 without modified bristlelike setae. 13
Antennal F-9 with modified bristlelike setae. 14

13(12). Modified tuft of antennal F-5 distinct, composed of 5, 6 narrow, acute scales, as long as the next 2, 3 flagellomeres: F-8 with a slender, gently hooked tuft (Fig. 39). . . . . *ganapathi*
Modified tuft of antennal F-5 indistinct, composed of 4-7 short, acute setae as long as 1 flagellomere; F-8 with a thick, more weakly hooked tuft (Fig. 41). . . . . *spiculosus*

14(12). Modified tuft of antennal F-5 conspicuous, with some broad blunt-tipped scales (*pholeter* complex). . . . . *pholeter*
Modified tuft of antennal F-5 small, inconspicuous, with short setae only or absent. 15

15(14). Modified tuft of antennal F-5 with a small tuft of 3-5 very short spinelike setae (Fig. 43) (*minor* complex, in part). 16
Modified tuft of antennal F-5 absent or not developed. 22

16(15). Basimere with 15-17 submarginal setae, in 2, 3 prominent rows strongly diverging laterad on lateral tergal surface (Fig. 45). *bandoengensis*
Basimere with 4-7 submarginal setae in 1 row, more or less parallel to tergomesal margin. 17

17(16). Distal part of subapical lobe elongate and hairy (Fig. 45). . *tuberis*
Distal part of subapical lobe not as above. 18

18(17). Proboscis strongly swollen in middle, with many strong, prominent setae on lateral and ventral surfaces. . . . . *bicornutus*
Proboscis uniformly thick, without numerous strong setae on lateral and ventral surfaces as above. 19

19(18). Rod *a* of subapical lobe markedly curved in middle, distally separated from rods *b,c* by a wide gap; basimere with 6, 7 very strong submarginal setae (Fig. 43). . . . . *minor*
Rod *a* of subapical lobe gently curved or straight and largely overlapped with rods *b, c*; basimere with 4-7 weaker submarginal setae (Figs. 46-48). 20

20(19). Antennal F-9-11 with a few to several short or long setae distad of normal whorls (Fig. 47). 21
Antennal F-9-11 without any setae distad of normal whorls. . *kuhnsi*

21(20). Basimere with 4 submarginal setae; F-9-11 with several long setae distad of normal whorls. . . . . *crassicomus*
Basimere with 6, 7 submarginal setae; F-9-11 with 1, 2 short setae distad of normal whorls. . . . . *incomptus*

22(15). Internal process of phallosome strong and long, its apex reaching base of apical lobe of external process; external process slender with several strong denticles (Fig. 49)(*minor* complex, in part). *bengalensis*
Internal process of phallosome weak and rather short, its apex not reaching base of apical lobe of external process; external process broad, with or without a small number of weak denticles (*peytoni* complex). 23

23(22). Modified tufts of antennal F-6, 7 very weakly developed and rather indistinct; subapical lobe of basimere with numerous fine hairlike setae associated with usual specialized setae on mesal surface (Fig. 52). . . . . *eukrines*
Modified tufts of antennal F-6, 7 well developed and distinct; subapical lobe of basimere without any fine hairlike setae associated with usual specialized setae as above (Fig. 50). *peytoni*

Brevipalpus Subgroup

24(2). Antennal F-5 with a distinct modified tuft of 4, 5 narrow, acute scales; F-6 with a crumpled tuft of twisted or curled setae (*navalis* complex). 25
Antennal F-5 without modified tuft of setae or scales; F-6 with 4, 5 subapically swollen scales in a row (Fig. 61) (*hewitti* complex). *hewitti*

25(24). Rod *a* of subapical lobe stout, strongly curved and distally separated from rods *b,c* by a wide gap (Fig. 58). . . . . *navalis*
Rod *a* of subapical lobe slender, more or less straight and largely overlapping with rods *b,c* (Fig. 60). . . . . *coerulescens*

26(1). Distimere normal, distally tapered into a recurved point; basimere small, conical; subapical lobe small, with only a few accessory setae in group *d-f* (Fig. 63) (*jenseni* complex). . . . . *jenseni*
Distimere with modified expanded apex; basimere relatively large and broad; subapical lobe large, usually with several accessory setae in group *d-f* 27

27(26). Subapical lobe with numerous accessory setae in group *d-f*; leaflet g_1 not developed or absent (*brevipalpus* complex). 28
Subapical lobe with only a few accessory setae in group *d-f*; leaflet g_1 present, very broad, heart-shaped (*curtipalpis* complex). . 31

28(27). Antennal F-9 with a weak tuft of 4, 5 bristlelike setae. 29
Antennal F-9 with a strong tuft of 10 or more flattened setae. *eminentia*

29(28). Seta h of subapical lobe very strong and long, of the same magnitude as proximal rods (Fig. 65). . . . . *brevipalpus*
Seta *h* of subapical lobe weaker and shorter than proximal rods or sometimes reduced, inconspicuous (Figs. 67, 68). 30

30(29). Antennal F-8 with a strong modified tuft; setae of subapical lobe as detailed in Fig. 67. . . . . *lucaris*
Antennal F-8 with weaker modified tuft; setae of subapical lobe as detailed in Fig. 68. . . . . *acutipalpus*

31(27). Antennal F-5-9 with distinct tufts of modified setae. . . *curtipalpis*
Antennal F-5-9 without distinct tufts of modified setae. . *sumatranus*

PUPAE[1]

1. Trumpet long, cylindrical, 0.5-0.7 mm; breed in tree holes, bamboos, rock pools, leaf axils or ground pools (*Mammilifer* Subgroup). 2
Trumpet short, bell-shaped or funnel-shaped, 0.2-0.4 mm; breed in pitcher plants (*Brevipalpus* Subgroup). 19

Mammilifer Subgroup

2(1). Pinna of trumpet with slit extending to meatus; setae 6-III-VI 4, 5 branched (except *pholeter*); usually breed in ground pools or sometimes rock pools. 3

[1] *incomptus* and *crassicomus* are unknown.

Pinna of trumpet without slit extending to meatus; setae 6-III-VI usually 1-3 branched; breed in tree holes, bamboos, rock pools or leaf axils. 7

3(2). Seta 5-C double, strong, about 2 times as long as 7-C. . . . *pholeter*
Seta 5-C 4-6 branched, as long as or shorter than 7-C. 4

4(3). Seta 8-C usually 3, 4 branched; 5-IV double or triple; apex of paddle pointed or rounded. 5
Seta 8-C usually double; 5-IV 5, 6 branched; apex of paddle rounded. 6

5(4). Seta 10-C 3, 4 branched; apex of paddle pointed. . . . . *flavicornis*
Seta 10-C double; apex of paddle rounded. . . . . *lasiopalpis*

6(4). Seta 4-VIII usually triple; 6-IV-VI usually 5 branched. . *mammilifer* and *wardi*
Seta 4-VIII double; 6-IV-VI usually 4 branched. . . . . *bengalensis*

7(2). Seta 11-C usually single. 8
Seta 11-C usually double. 13

8(7). Seta 10-C 3, 4 branched; 8-C 3, 4 branched. . . . . *kuhnsi*
Seta 10-C double; 8-C usually double. 9

9(8). Seta 5-C strong and long, about 2 times as long as 7-C; trumpet very long and thin, index 15-20. . . . . *ganapathi*
Seta 5-C weaker, as long as or shorter than 7-C; trumpet moderately long and thick, index 7-10. 10

10(9). Seta 5-IV triple; 5-IV-VI as long as or shorter than segment following. 11
Seta 5-IV single; 5-IV-VI 1.5-2.0 times longer than segment following. 12

11(10). Seta 5-V single; 6-IV, V usually double. . . . . *spiculosus*
Seta 5-V double or triple; 6-IV, V usually single. . . . . *traubi*

12(10). All setae strong and long; 6-III-V usually triple; 5-IV-VI usually 2 times longer than segment following. . . . . *eukrines*
All setae relatively weaker and shorter; 6-III-V usually double; 5-IV-VI 1.5 times longer than segment following. . . . . *peytoni*

13(7). Seta 10-C usually single and weak. . . . . *impostor*
Seta 10-C usually double and strong. 14

14(13). Paddle with broadly rounded apex. 15
Paddle with acuminate or pointed apex. . . . . *tuberis*

15(14). Seta 5-IV usually triple. 16
Seta 5-IV double. 17

16(15). Seta 9-VII 5, 6 branched; 5-V, VI single, strong, nearly 2 times longer than segment following. . . . . *demissus*
Seta 9-VII 3, 4 branched; 5-V, VI double, weak, slightly longer or shorter than segment following. . . . . *lavatae*

17(15). Seta 5-C 5, 6 branched; length of trumpet 0.5 mm, index 8. *uniformis*
Seta 5-C 2-4 branched; length of trumpet 0.7 mm or more, index at least 10. 18

18(17). Seta 8-C usually triple. . . . . *bandoengensis*
Seta 8-C double. . . . . *minor* and *bicornutus*

Brevipalpus Subgroup

19(1). Trumpet elongate, funnel-shaped, 0.4 mm in length. 20
Trumpet short, bell-shaped, 0.2-0.3 mm in length. 23

20(19). Seta 5-C single; 10-C single. . . . . *jenseni*
Seta 5-C 5, 6 branched, 10-C 3, 4 branched. 21

21(20). Seta 5-IV, V single. . . . . *hewitti*
Seta 5-IV, V usually triple and double respectively. 22

22(21). Seta 8-C subequal to 9-C; 12-C 3, 4 branched. . . . . *navalis*
Seta 8-C distinctly longer than 9-C; 12-C double. . . . *coerulescens*

23(19). Seta 9-VIII single, 0.5-1.0 of paddle length. 24
Seta 9-VIII 4 branched, 0.25 of paddle length. . . . . *curtipalpis* *sumatranus*

24(23). Most setae very strong and long; seta 5-C 3-4 times as long as trumpet; 5-IV-VI 0.1-1.5 times as long as segment following; 9-VIII 0.5 of paddle length. . . . . *brevipalpus* and *acutipalus*
Most setae relatively weaker than above; seta 5-C 1-2 times as long as trumpet; 5-IV-VI 0.5-1.0 as long as segment following; 9-VIII 0.5 of paddle length. . . . . *eminentia* and *lucaris*

LARVAE[1]

1. Setae 2, 3-A placed subapically; habitats: tree holes, bamboos, rock pools, leaf axils or sometimes ground pools (*Mammilifer* Subgroup). 2
Setae 2, 3-A placed apically; habitats: pitcher plants (*Brevipalpus* Subgroup). 19

[1] *incomptus* and *crassicomus* are unknown.

Mammilifer Subgroup

2(1). Thorax and abdomen heavily spiculate, spicules large, setiform and very distinct under low magnification. 3
Thorax and abdomen unspiculate or lightly spiculate, spicules weak, dotlike, not distinct as above. 5

3(2). Spicules of thorax and abdomen branched; ventral surface of head capsule with a transverse band of numerous spicules. . . *kuhnsi*
Spicules of thorax and abdomen unbranched; ventral surface of head capsule without transverse bands of spicules. 4

4(3). Seta 5-C 3-5 branched; 7-P triple; posterior caudal margin of saddle with numerous strong, spinelike spicules. . . . . *uniformis*
Seta 5-C double; 7-P usually double; posterior caudal margin of saddle lightly spiculate, spicules not as strong as above. *spiculosus*

5(2). Setae 1-III-VI single; seta 8-P usually minute, inconspicuous, of the same magnitude as seta 14-P. . . . . *pholeter*
Setae 1-III-VI double or more branched; seta 8-P strong, distinct, nearly subequal to 7-P. 6

6(5). Seta 8-P double; head capsule, siphon and saddle pale yellowish white. 7
Seta 8-P single; head capsule, siphon and saddle dark yellow to brown. 9

7(6). Seta 14-P single; 1-M shorter or as long as 3-M; 1-T as long as 2-T. 8
Seta 14-P double; 1-M longer than 3-M; 1-T longer than 2-T, of the same magnitude as 6-T. . . . . *bengalensis*

8(7). Siphon with 3 pairs of subventral tufts, comb scales 30-50. *mammilifer*, *wardi* and *lasiopalpis*
Siphon with 4 pairs of subventral tufts, comb scales 50 or more. *flavicornis*

9(6). Setae 6-I, II double; siphon with 3 pairs (total 6) of subventral tufts. 10
Setae 6-I, II triple or with 2 long, lateral branches and 1 weak median branch; siphon with 4 pairs (total 8) of subventral tufts. 12

10(9). Comb scales with round apical fringe of evenly fine spicules; thorax and abdomen moderately spiculate. . . . . *bandoengensis*
Comb scales with pointed apical fringe, or terminated into a strong median spine; thorax and abdomen lightly spiculate. 11

11(10). Pecten teeth barbed with graded denticles (Fig. 44). . . . *bicornutus*
Pecten teeth barbed with 1-3 strong basal denticles and 7, 8 graded denticles distally (Fig. 44). . . . . *minor*

12(9). Seta 1-VIII weak, short, less than 0.5 of 5-VIII, double or triple. *tuberis*
Seta 1-VIII as long as or subequal to 5-VIII, 4, 5 branched. . . . 13

13(12). Seta 5-C 3, 4 branched; thorax and abdomen usually lightly to moderately spiculated, spicules visible under 10X objective. 14
Seta 5-C double; thorax and abdomen usually unspiculated or lightly spiculated. 15

14(13). Seta 6-VI usually single, longer than 6-III-V; posterior comb scales with apical fringe of evenly fine spicules. . . . . *traubi*
Seta 6-VI double, as long as 6-III-V; posterior comb scales with apical fringe terminated into a strong median spine. . . . *lavatae*

15(13). Subventral tufts of siphon dark, strong, 4-5 times as long as siphonal width at points of attachment, usually 4 branched. . 16
Subventral tufts of siphon pale, weak, 1-2 times as long as siphonal width at point of attachment, double or triple. 17

16(15). Seta 1-C usually swollen at middle or distally forked into 2, 3 apical spines; lateral setae of thorax and abdomen pale or moderately pigmented; antennal shaft, siphon and saddle usually pale yellow. *ganapathi*
Seta 1-C slender, single, spiniform; lateral setae of thorax and abdomen dark; antennal shaft, siphon and saddle dark brown. *impostor*

17(15). Head, siphon and saddle dark brown; siphon very long, index 14-19; subventral tufts very weak, inconspicuous and widely spaced. *demissus*
Head, siphon and saddle pale yellow; siphon relatively shorter, index 7-9; subventral tufts distinct and more closely spaced. . 18

18(17). Seta 6-C single; spicules of antennal shaft weak and fine. . *eukrines*
Seta 6-C double; spicules of antennal shaft stronger. . . . . *peytoni*

Brevipalpus Subgroup

19(1). Siphon longer than saddle; subventral tufts strong, prominent, 6-9 pairs (total 12-18). 20
Siphon shorter than saddle; subventral tufts very weak, 3 pairs (total 6). . . . . *curtipalpis* and *sumatranus*

20(19). Siphon very slender and thin; seta 1-A strong, with 10-15 pectinate branches. 21
Siphon broad and thick; seta 1-A weak, with 3-6 simple branches. . . 23

21(20). Seta 5-C single or double; siphon brownish, lightly swollen in middle or elliptical in shape. 22
Seta 5-C 6-9 branched; siphon pale yellow, tubular, or gradually tapered towards apex. . . . . *hewitti*

22(21). Antennal shaft entirely pale or cream-colored; seta 5-C single. *navalis*
Antennal shaft dark brown; seta 5-C double. . . . . *coerulescens*

23(20). Seta 1-C dark, stout, spiniform; 6-C triple, subequal to 5-C, both in normal position. . . . . *jenseni*
Seta 1-C pale, distally filamentous; 6-C single, longer than 5-C, both placed cephalad. 24

24(23). Seta 7-II strong and dark, subequal to 7-I. 25
Seta 7-II weak and pale, considerably shorter than 7-I. . *lucaris*

25(24). Seta 8-P usually double; siphon with 8-9 pairs of subventral tufts. *brevipalpus*
Seta 8-P usually triple; siphon with 6-8 pairs of subventral tufts. .26

26(25). Ventral brush (4-X) usually with 5 pairs of setae; subventral tufts of siphon usually 6-7 pairs. . . . . *acutipalus*
Ventral brush (4-X) usually with 6 pairs of setae; subventral tufts of siphon usually 7-8 pairs. . . . . *eminentia*

Mammilifer Subgroup

The *Mammilifer* Subgroup essentially conforms to the description of Colless (1965: 264). It is chiefly characterized by the following characters: in the adults by the erect scales on vertex of head entirely dark and the presence of 1 lower *mep* bristle (except *uniformis*, *bengalensis*, *flavicornis* and *lasiopalpis*); the female cibarial armature by cibarial bar with 30-40 subequally long teeth (except *pholeter*); the male by palpus usually as long as or longer than proboscis; the male genitalia by (1) basimere normal, slender, conical, with 4 or more strong submarginal setae in a prominent row or rows; (2) subapical lobe as described for the group; leaflet g_1 well developed; (3) distimere slender, strongly tapered and recurved towards apex and (4) internal process of the phallosome usually strong, prominent or well developed; the pupa by trumpet very long, more or less uniformly cylindrical, 0.6-0.8 mm in length and in the larva by (1) setae 2, 3-A placed subapically; (2) siphon slender, long, distally tapered, 4-7 times as long as saddle and (3) subventral tufts of siphon 3, 4, pairs (total 6-8). Breeding habitats: usually tree holes, bamboos and rock pools, sometimes leaf axils and ground pools.

DISCUSSION. The *Mammilifer* Subgroup is represented in the Oriental region by 22 species. The majority of these have been described from Southeast Asia where the subgroup is better represented than anywhere else. The subgroup is highly complex and taxonomically difficult mainly because many of the forms involved are only slightly different from one another and show considerable overlap in their breeding sites and distribution. The identity of most species can be determined with certainty by examining the details of the male antennae and genitalia, larval and pupal stages. Special caution should be taken in using the characters given in the keys and descriptions.

To illustrate the evolutionary pattern as exhibited by the male antennal modified tufts, palpus and genitalia, the 22 Oriental species of the *Mammilifer* Subgroup are classified into 8 complexes: *impostor*, *traubi*, *mammilifer*, *ganapathi*, *minor*, *peytoni*, *pholeter* and *flavicornis*. On the basis of the male

phallosome alone, the first 7 complexes appear to fall into 2 major lines: (1) *mammilifer* line with *impostor*, *traubi* and *mammilifer* complexes and (2) *minor* line with *ganapathi*, *minor*, *peytoni* and *pholeter* complexes. Each of these complexes and its included species are briefly characterized as follows.

(1) *impostor* complex. This complex is represented only by *impostor*. It is characterized in the male by: (1) palpus 0.75 of proboscis length and (2) absence of modified tufts of scales and setae on the antennal flagellum; in the male genitalia by (1) phallosome with internal process as long as or longer than external process and (2) external process slender, narrow in tergal aspect and with a broad, densely spiculose apical lobe.

(2) *traubi* complex. This complex is represented by *traubi*, *uniformis* and *lavatae*. It is characterized in the male by: (1) palpus as long as or slightly longer than proboscis and (2) modified tufts of scales and setae present on antennal flagellomeres 6-8 or 5-8; in the male genitalia by (1) phallosome with internal process longer than external process and (2) external process as in *impostor* complex.

(3) *mammilifer* complex. This complex includes *mammilifer*, *wardi* and *demissus*. It is similar to the *traubi* complex in the male phallosome but differs from it in the presence of modified tuft of bristlelike setae on antennal flagellomere 9 in addition to those on flagellomeres 5-8.

(4) *ganapathi* complex. This complex consists of *ganapathi* and *spiculosus*. It is essentially similar to the *traubi* complex in the male palpus and antenna but differs from it particularly in the following characters of the male phallosome: (1) lateral plate with internal process distinctly shorter than external process; (2) external process broader in tergal aspect and (3) apical lobe of external process small, placed sternad and with distinct basal stalk.

(5) *minor* complex. The *minor* complex is the largest, comprising 8 species, including *minor*, *bicornutus*, *bandoengensis*, *tuberis*, *kuhnsi*, *crassicomus*, *incomptus* and *bengalensis*. It is similar to the *mammilifer* complex in having modified tufts of scales and setae present on antennal flagellomeres 5-9 and palpus as long as or slightly longer than proboscis but the male phallosome resembles the *ganapathi* complex except for the apical lobe of the external process, which is larger, with or without distinct basal stalk.

(6) *peytoni* complex. This complex is represented by *peytoni* and *eukrines*. It is differentiated from the *minor* complex by (1) absence of distinct modified tuft on antennal flagellomere 5; (2) external process of phallosome larger and broader; (3) internal process smaller, much shorter than external process and (4) apical lobe of external process very minute, rudimentary and weakly spiculate.

(7) *pholeter* complex. This complex includes only *pholeter*. It is similar to the *peytoni* complex in the male phallosome, but differs from the latter in having a distinct scale tuft on antennal flagellomere 5.

(8) *flavicornis* complex. This complex is represented by *flavicornis*, *lasiopalpis* and *raghavanii*. It is differentiated from all other complexes in the male by (1) palpus longer than proboscis by more than the length of segment 5; (2) palpal segments 2 and 3 with prominent lateral rows of numerous fine setae and (3) modified tufts present on antennal flagellomeres 5-9; in the male genitalia by (1) distimere with a normal or modified, expanded apex; (2) phallosome with internal process shorter than external process and (3) apical lobe of external process very small or rudimentary.

impostor complex

24. *CULEX (LOPHOCERAOMYIA) IMPOSTOR* NEW SPECIES
(Fig. 29)

FEMALE. Wing: 2.9 mm. Forefemur: 1.5 mm. Proboscis: 1.8 mm. Small to medium sized species; in general conforms to the description of the *Mammilifer* Group and Subgroup. *Head*. Decumbent scales in center of vertex very narrow; linear and predominantly pale whitish; erect scales slender, entirely black; lateral patch of broad scales pure white, very distinct. Palpus slender, dark scaled, 0.2 of proboscis length. Proboscis dark, slender; labial basal setae weak, 0.5 of palpal length. *Cibarial Armature*. Cibarial bar with a close-set row of about 30 elongate teeth, 3,4 median teeth fine and apically pointed, lateral teeth coarser and apically blunt or abruptly pointed. *Thorax*. Mesonotal integument black; mesonotal scales narrow, entirely black and moderately dense. Pleuron same color as mesonotum; 1 lower *mep* bristle present. *Legs*. Anterior surface of hindfemur with a broad white stripe extending from base to apex. *Wing*. Plume scales on veins R_2, R_3 narrow, linear. *Abdomen*. Terga entirely dark or black; sterna pale whitish.

MALE (Fig. 29). Essentially similar to female in general external characters. *Palpus*. Rather short, 0.75-0.80 of proboscis length; segments 4 and 5 strongly reduced in length, with only a few bristles and setae. *Proboscis*. Slender, uniformly thin; labial basal setae weak, short and pale. *Antenna*. Pedicel with a spiculose nipplelike prominence projecting outwards on inner dorsal surface; flagellar whorls weakly to moderately plumose, modified tufts of scales and setae completely absent.

MALE GENITALIA (Fig. 29). As figured, essentially as described for the *Mammilifer* Subgroup. *Segment IX*. Tergal lobe very small, bearing 2 weak setae; sternum with 2 strong setae towards caudal margin. *Basimere*. Small, slender, conical, 0.2 mm in length; inner tergal surface with a row of 4 or sometimes 3, moderately strong submarginal setae which are rather widely spaced. *Subapical Lobe*. Mesal surface with several weak setae at base of setae *d-f*; rodlike setae *a-c* slender, gently curved, all terminated into a fine hook apically; setae *d-f* consist of 3 acute blades, all apparently bent upwards; leaflet g_2 in form of a strong acute blade, distad of setae *d-f;* leaflet g_1 narrow, lanceolate, as long as leaflet g_2; seta *h* strong and long. *Distimere*. Slender, normal, as long as basimere; dorsal subapical crest of spicules not developed; 1 dorsal and 1 ventral tiny seta present, dorsal one rather inconspicuous; subapical claw slender and short. *Phallosome*. Internal process of apical dorsal lobe of lateral plate very strong and long, usually projecting beyond apex of external process, its base provided with variable number of strong denticles; external process narrow in tergal aspect, with 1,2 rows of 10-12 strong denticles on tergal surface and a broad, densely spiculose apical lobe, its inner surface with variable number of teeth. *Proctiger*. Apical crown large, composed of 4-7 flattened and apically blunt spicules laterally and numerous finer spicules mesally; paraproct and cercal sclerite well sclerotized; cercal setae 2-4.

PUPA (Fig. 29). Abdomen: 2.7 mm. Paddle: 0.62 mm. Trumpet: 0.60 mm; index 10-12. Cephalothorax and abdomen more or less uniformly brown. *Trumpet*. Deep brown and uniformly cylindrical; meatus weakly spiculate. *Cephalothorax*. Seta 1-C single or double; 5-C as long as 7-C, 3,4 branched; 8-C weak, subequal to 9-C, double. *Metanotum*. Seta 10-C weak, usually single (1-2); 11-C strong, double; 12-C subequal to 10-C, double. *Abdomen*.

Seta 5-IV double or triple, 1.5 times as long as segment following; 5-V single, very long, about twice longer than segment following; 5-VI single, short, as long as or shorter than segment following; 6-III-VI usually double (1-2); 9-VII with 4 pectinate branches; 4-VIII single; 9-VIII with 8 pectinate branches. *Paddle*. Very pale to almost transparent except for external basal margin of outer part and midrib which are lightly pigmented.

LARVA. Head: 0.70 mm. Siphon: 1.8 mm; index 15. Saddle: 0.25 mm; siphon/saddle ratio 8-9. In general as figured for *traubi* (Fig. 31). *Head*. Pigmentation variable, generally yellowish, with pattern of dark brown areas, seta 1-C dark, slender and moderately long; 4-C single, 2,3 times as long as distance between bases of the pair; 5,6-C dark, as long as antenna, double. Antenna shaft entirely brownish; spicules weak and rather sparse. *Thorax*. Spiculation absent or poorly developed; seta 3-P single, about 0.5 of 1,2-P; 4-P double; 7-P double; 8-P single; usually subequal to 7-P, sometimes strongly reduced to 0.25 of the latter; major setae of mesothorax and metathorax dark. *Abdomen*. Spiculation absent; setae 6,7-I and 6-II very dark and stout; 6-I,II triple; 7-I double; 6-III-VI usually double (2-3). Comb scales about 40, in broad oval patch; posterior scales elongate, with fringe of evenly fine spicules. Saddle dark brown; posterior caudal margin very weakly spiculate; seta 2-X usually triple (2-3); ventral brush dark, with 6 pairs of branched setae. *Siphon*. Very slender, dark brown, pecten teeth 9-10, each with 2,3 strong, widely spaced basal denticles and an inconspicuous distal fringe of several fine denticles; subventral tufts moderately long, widely spaced, double or triple each, 2-4 times as long as siphonal width at point of attachment.

TYPE-DATA. Holotype ♂ (S 494-11) with associated pupal and larval skins and slide of genitalia, Sapulut, Pensiangan, *Sabah*, MALAYSIA; tree holes, rain forest, 600 feet (approx. 180 m), April 12, 1970, Sulaiman B. Omar and Chia Y. Wang (USNM). Allotype ♀ (S 488-12) with associated pupal and larval skins (USNM); paratypes: 3♂ (S 486-10, S 488-13, S 494-12) with associated pupal and larval skins; 9♂, 4♀ (S 486, S 488, S 489, S 498), 1 lp (S 493-21), same data as holotype, April 11-12, 1970 (USNM).

DISTRIBUTION. Known only from Sabah and Sarawak, Malaysia; 43 specimens examined: 37♂, 6♀, 1 lp; 5 with associated lp skins.

MALAYSIA. *Sabah:* Sapulut, Pensiangan (type-locality); 13♂, 5♀, 6 lp. *Sarawak:* Kapit; 24♂, 1♀ (collected by K. J. Frogner, 1971).

TAXONOMIC DISCUSSION. *Culex impostor* is strongly differentiated from all other members of the *Mammilifer* Subgroup in the male by the complete absence of modified tufts of setae on the flagellomeres of the antenna. Because of the absence of these antennal characters and the relatively short palpus, the males of *impostor* are superficially similar to certain members of the subgenus *Eumelanomyia*. A detailed study of the male, including the genitalia, however, indicates that it exhibits characteristic features of the *Mammilifer* Subgroup of *Lophoceraomyia* in having a distinct spiculose prominence on the antennal pedicel and in the type of the phallosome. Among the members and complexes of the *Mammilifer* Subgroup, *impostor* apparently shows a strong affinity with the *traubi* and *mammilifer* complexes. It can be readily separated from the members of these complexes in all stages as indicated in the keys and as described above.

BIONOMICS. All of the adults and immatures of *impostor* were collected from jungle tree holes at an elevation of about 180 m. It has been encountered on several occasions and appears to be common in Sarawak and Sabah.

traubi complex

25. *CULEX (LOPHOCERAOMYIA) TRAUBI* COLLESS
(Figs. 30, 31)

Culex (Lophoceraomyia) traubi Colless 1965: 295 (♂*, ♀, L); Bram 1967a: 108 (♂*, ♀, L*).

FEMALE. Wing: 2.6 mm. Forefemur: 1.4 mm. Proboscis: 1.6 mm. Small species, exceedingly similar to *impostor*, differing slightly in the following features. *Head*. Narrow decumbent scales of vertex broader on upper eye margin, forming a distinct ocular line, scales in center of vertex narrow, linear and predominantly dark; lateral patch of broad whitish scales broader, more conspicuous. Labial basal setae of proboscis longer, about 0.75 of palpal length. *Cibarial Armature*. Cibarial teeth narrower, finer, all with pointed apices. *Thorax*. Mesonotal scales dark and somewhat glossy in appearance. *Legs*. Anterior surface of hindfemur largely pale whitish in basal 0.5, continued as broad pale stripe towards apex.

MALE (Fig. 30). As described by Colless (1965: 295) and Bram (1967a: 108); with the following diagnostic characters. *Palpus*. As long as or slightly shorter than proboscis; segments 4, 5 with only a few dark bristles. *Proboscis*. Uniformly slender and thin from base to apex. *Antenna*. Flagellar whorls moderately to strongly plumose; modified tufts of scales and setae present, restricted to flagellomeres 5-8; F-5 with a small tuft of 5, 6 narrow acute golden scales, preceded dorsally by 2, 3 long normal hairs, dorsalmost scales longest, as long as the next 2 flagellomeres, rest gradually shorter and narrower; F-6, 7 with moderately strong crumpled tufts of curled and twisted setae; F-8 with a prominent tuft of 5, 6 fused setae which are weakly curved subapically or not in form of a typical J-hook; F-9 apparently without any modified setae.

MALE GENITALIA (Fig. 30). As figured. *Segment IX*. Tergal lobe with 3, 4 weak and short setae; sternum with 2-8 strong setae in a transverse row towards caudal margin. *Basimere*. Slender, small, about 0.22 mm in length; inner tergal surface with a prominent row of 6-10 strong submarginal setae which are closely spaced, parallel to tergomesal margin; marginal setae rather strong, 15-20 in number. *Subapical Lobe*. Rodlike setae *a*-*c* subequal, smoothly curved, largely overlapping in distal portion; setae *d*-*f* consist of 4 short pointed blades and 2 or more fine hairlike setae which are densely packed; leaflet g_2 in form of a long gently curved blade; leaflet g_1 broad, acuminate; seta *h* moderately strong. *Distimere*. Dorsal subapical crest of fine spicules absent. *Phallosome*. Very similar to *impostor;* internal spinelike process very strong and long, projecting beyond apex of external process, its base without any denticles; external process with a broad spiculose apical lobe and 1-3 rows of several strong denticles on upper tergal surface, inner surface without any denticles. *Proctiger*. Apical crown composed of numerous dark, coarse spinelike spicules; cercal setae 3, 4.

PUPA (Fig. 30). Abdomen: 2.2 mm. Paddle: 0.62 mm. Trumpet: 0.52 mm; index 8-10. Pigmentation of cephalothorax and abdomen variable from yellowish to brownish. *Trumpet*. Moderately long, dark brown; meatus strongly spiculate. Chaetotaxy as figured, the following setae are diagnostic. *Cephalothorax*. Seta 1-C usually double; 5-C usually triple, as long as 7-C; 8, 9-C double. *Metanotum*. Seta 10-C double, as long as 11-C; 11-C single;

12-C usually double (2-3). *Abdomen*. Seta 5-IV usually triple (3-5), shorter than segment following; 5-VI single or double, subequal to or shorter than 5-IV, V; 6-III double; 6-IV-VI single; 9-VII usually triple (2-4); 4-VIII double; 9-VIII 6, 7 branched. *Paddle*. Relatively narrow, entirely pale except for lightly darkened midrib.

LARVA (Fig. 31). Head: 0.70 mm. Siphon: 1.4-2.0 mm (average 1.8 mm); index 9-11. Saddle: 0.30 mm; siphon/saddle ratio 5, 6. As characterized for the *Mammilifer* Subgroup, with the following diagnostic features. *Head*. Seta 1-C dark, slender, spiniform or sometimes lightly swollen at base, with or without lateral accessory spines; 5-C usually triple (2-5); 6-C usually double (2-3). Antennal shaft usually entirely dark brown, sometimes lighter. *Thorax*. Lightly spiculate, spicules minute, rather inconspicuous; seta 8-P strong, subequal to 7-P, single; 7-P double; 14-P double; 1-M as long as 3-M, both setae single. *Abdomen*. Spiculation absent; setae 6-I, II triple, 7-I double; 1-III-VI usually double (2-3); 6-III-V usually double (2-3); 6-VI usually single (1-2) and very long, 2 times as long as 6-III-V; 1, 4-VII single; 7-VII usually 4 branched (3-4). Comb scales 32-45, posterior scales longer than anterior ones, all with apical fringes of evenly fine spicules. Saddle brownish, posterior caudal margin lightly to moderately spiculate; seta 2-X double; anal gills at least 2 times as long as saddle. *Siphon*. Slender, yellowish to dark brown; length extremely variable; pecten teeth 12, slender, each tooth with 1, 2 large basal denticles and 4, 6 fine distal denticles, latter rather inconspicuous; subventral tufts strong, 4 pair in number, first 2 proximal pair double or triple, 4, 5 times as long as siphonal width at point of attachment; next 2 distal pair much shorter, 4-6 branched each, 1, 2 times as long as siphonal width; median caudal filament of spiracular apparatus not developed or absent.

TYPE-DATA. Holotype ♂ with associated pupal and larval skins (0453/C44), slides of antenna (CH 162) and genitalia (CT 586), Ulu Gombak, *Selangor, Malaya* [(Peninsular Malaysia), MALAYSIA,] , 10 May 1958, D. H. Colless (ANIC).

DISTRIBUTION. Thailand, Malaysia and Indonesia. 105 specimens examined: 53♂, 40♀, 12 L; 68 with associated immature skins (12 p, 56 lp).

THAILAND. *Mae Hong Son:* Doi Chang; *Nakhon Nayok:* Khao Yai; *Ranong:* Koh Chang; *Trang:* Muang; 4[, 5 L, 2 p, 2 lp.

MALAYSIA. *Peninsular Malaysia - Selangor:* Ulu Gombak; Ulu Langat; Ampang, F. R., Bt. Ulu Bakau; Kg. Tanjong Robok; Bt. Kutu; *Selangor-Pahang:* The Gap; *Pahang:* Gunong Benom; Cameron Highlands; *Perak:* Kg. Jalong; *Perlis:* Bt. Bintang F. R. ; 23♂, 27♀, 7 L, 9 p, 29 lp. *Malaysia* (N. Borneo) - *Sabah:* Tawau; Mt. Kinabalu; Beaufort; Tenom; Pensiangan; 25♂, 13♀, 3 p, 25 lp.

INDONESIA. *Sumatra:* Bengkoelen; 1♂ (Thienemann, 28 Jan. 29).

TAXONOMIC DISCUSSION. *Culex traubi* is one of the most common species of the *Mammilifer* Subgroup and is probably more widespread than the above records indicate. It can be recognized in the male by (1) the absence of modified setae on antennal flagellomere 9; (2) the form of the modified tuft of antennal flagellomere 8 and (3) the small, yellowish or golden tuft of 5, 6 narrow, acute scales of antennal flagellomere 5; the male genitalia by (1) the very long internal process of the phallosome; (2) the prominent row of 6-10 strong submarginal setae of the basimere and (3) the gently curved and largely overlapped setae *a-c* of the subapical lobe; the pupa by (1) the dark brown and strongly spiculate trumpet; (2) the single seta 11-C and (3) the relatively short setae 5-IV-VI which are usually 3, 2 and 1-2 branched respectively, and in the

larva by (1) seta 5-C usually triple; (2) setae 1-III-VI usually double; (3) the usually single and long seta 6-VI; (4) the strong subventral tufts of the siphon and (5) the usually dark brown pigmentation of the saddle and siphon.

The *traubi* larva is very variable in the length and color of the siphon and branches of abdominal setae 1-III-VI, but these have not been found to be correlated with any differences in the male and pupa, indicating that probably only a single form is involved.

The relationship of *traubi* is apparently closest to *uniformis* from Sri Lanka and *lavatae* from the Philippines on the basis of the male phallosome and antenna, and together with the latter 2 species appears to fall into a complex. It can be readily separated from *uniformis* and *lavatae* as indicated in the keys and as in the descriptions of the latter 2 species.

BIONOMICS. The immatures of *traubi* have been most frequently collected from tree holes in the jungle at a broad range of elevation from 70-1,700 m. In several recent collections in Malaysia, they were also found breeding in bamboo stumps or fallen bamboos lying on the ground as frequent as in tree holes without showing preference for either type of breeding habitat. All of the larval collections from Thailand and most of the collections from Sabah came from tree holes. The majority of the adults came from rearing the pupae and larvae and only a few from sweeping among leaves of plants near the breeding sites. The adults possibly attack man on occasion (Colless 1965: 296). No data are available on their feeding behavior.

26. *CULEX (LOPHOCERAOMYIA) UNIFORMIS* (THEOBALD)
(Figs. 32, 33)

Lophoceratomyia uniformis Theobald 1905a: 245 (♂*, ♀).

Culex (Lophoceratomyia) uniformis (Theobald), Edwards 1922a: 281 (♂, key); Barraud 1924: 24 (♂, ♀); Barraud and Covell 1928: 678 (♀ buccopharyngeal armature); Edwards 1928: 276 (L): Edwards 1932: 197 (taxonomy); Barraud 1934: 373 (♂*, ♀, L).

Culex (Lophoceraomyia) uniformis (Theobald), Mattingly 1949: 226 (L, key); Stone, Knight and Starcke 1959: 235 (catalog).

FEMALE. Wing: 3.2 mm. Forefemur: 1.6 mm. Proboscis: 1.9 mm. Medium-sized species; in general as described for *traubi*, differing from it in the larger size and in the following characters. *Head*. Vertex with a broader ocular line of pale decumbent scales contrasting sharply with dark scales in center and the posterolateral area. Palpus and proboscis relatively thicker. *Cibarial Armature*. Cibarial teeth stronger; lateral teeth with blunt or truncate apices. *Thorax*. Lower *mep* bristle absent.

MALE (Fig. 32). Differing from *traubi* as described for the female and in the following features. *Palpus*. Longer, exceeding proboscis by the full length of segment 5; segments 4 and 5 with more bristles on lateral and mesal surfaces. *Antenna*. Flagellar whorls moderately long plumose; F-5 with a larger, more conspicuous tuft of 6,7 scales, 1-3 dorsalmost scales longest, dark, distally broad and apically pointed or blunt, as long as the next 3 flagellomeres, followed laterally by 4,5 very narrow, curved, acute, yellowish scales of decreasing length; F-6,7 with stronger tufts of curled setae; modified tuft of F-8 apparently thicker and distinctly curved in apical portion.

MALE GENITALIA (Fig. 32). As figured, differing from *traubi* in the following features. *Basimere*. Inner tergal surface with a row of 4 strong sub-

marginal setae; marginal setae sparse and weak. *Subapical Lobe*. Leaflet g_1 much larger, longer and striated. *Phallosome*. Apical lobe of external process of lateral plate more finely spiculose, denticles on tergal surface of external process weaker and apparently fewer.

PUPA. As figured and described for *traubi*, differing from it in the following features. *Trumpet*. Relatively shorter and stouter, about 0.5 mm in length, index 8. *Cephalothorax*. Seta 1-C stronger, as long as 5-C, usually triple; 5-C usually 5, 6 branched (3-6); 8-C double or triple, sometimes more branched. *Metanotum*. Seta 11-C double. *Abdomen*. Setae 5-IV, V 1.5-2.0 times as long as segment following; 5-IV usually double (2-3); 5-V single or double; 5-VI single, as long as segment following; 6-IV-VI weaker, usually double (1-2).

LARVA (Fig. 33). Head: 0.72 mm. Siphon: 1.6 mm; index 9. Saddle: 0.35 mm; siphon/saddle ratio 4, 5. As figured; strongly differentiated from *traubi* in having thorax and abdomen densely spiculose and in the following features. *Head*. Most setae stronger, more or less flattened and dark; seta 4-C flattened, pectinate; 5-C 3-5 branched; 6-C double or triple, sometimes 4 branched. Antenna shaft pale cream-colored. *Thorax*. Spicules strong, hairlike, unbranched and extremely dense all over; seta 7-P triple; 8-P minute, rather inconspicuous, 4, 5 branched; 1-M stronger and longer than 3-M. *Abdomen*. Spiculation as in thorax; setae 1-III-VI strong, dark, flattened, 4, 5 branched; 6-III-VI triple. Saddle densely spiculate; lateral caudal margin with numerous strong spines; seta 2-X 3, 4 branched. *Siphon*. Moderately long, pigmentation yellowish; pecten teeth 12-14, larger teeth with 2, 3 graded basal denticles and 1, 2 finer distal denticles, latter sometimes not developed; subventral tufts subequally strong, 4, 6 branched each; first proximal pair placed among pecten, 2, 3 times as long as siphonal width at point of attachment, the remaining pairs gradually shorter.

TYPE-DATA. Lectotype ♂* with attached genitalia mount and slide of head, *Peradeniya*, CEYLON [SRI LANKA], May 1902, collected by Green (BMNH; present selection).

DISTRIBUTION. Known only from India and Sri Lanka. 452 specimens examined: 216♂, 230♀, 6 L; 7 with associated immature skins (1 p, 6 lp).

INDIA. *Bombay:* Trombay; *Malabar:* Pudupadi; 2♂.

SRI LANKA. *Central Province:* Kandy District, Peredeniya (type-locality); Madugoda; Udawattekele; Wakarwatte; *Uva Province:* Monaragala District; *Southern Province*: Kanneliya; *Western Province:* Singharaja Forest; Morapitiya; Kalatuwawa; Labugama Reservoir; 214♂, 230♀, 6 L, 1 p, 6 lp.

Additional records from the literature. INDIA: Andaman Islands; Madras, Nilgiri Hills (Barraud 1924: 43).

TAXONOMIC DISCUSSION. *Culex uniformis* appears to be restricted to south India and Sri Lanka and probably does not occur anywhere else in the Oriental region. In Sri Lanka it is one of the 4 known representatives of the *Mammilifer* Subgroup. Of all stages of *uniformis*, the larva is very diagnostic, especially in the development of the remarkably strong and dense spicules on the thorax and abdomen. The only other species which exhibit strong spiculation similar to the *uniformis* larvae are *spiculosus* and *kuhnsi*, but detailed study has shown that each is distinct and can be readily separated from the others by features indicated in the key and descriptions. Because of the similarity in their larvae, *uniformis* has been confused in the past with *spiculosus* and *kuhnsi*. The records of *uniformis* by Delfinado (1966: 114) and Baisas (1974: 121, as subspecies *mercedesae*) from the Philippines are, in fact, those of *kuhnsi* and the record by Chu (1958: 109-13) from Hainan Island, China,

is probably that of *spiculosus*.

BIONOMICS. *Culex uniformis* is apparently the most common *Lophoceraomyia* species in Sri Lanka. All larval collections from this area came from jungle tree holes. In India, it was collected from rock pools (Barraud 1934: 374).

27. *CULEX (LOPHOCERAOMYIA) LAVATAE* STONE AND BOHART
(Fig. 32)

Culex (Lophoceraomyia) lavatae Stone and Bohart 1944: 220 (♂*); Delfinado 1966: 107 (♂*, ♀); Baisas 1974: 112 (♂*, ♀, P*, L*).
Culex fidelis Dyar 1920: 180 (in part).

FEMALE. Wing: 2.8 mm. Forefemur: 1.4 mm. Proboscis: 1.8 mm. Extremely similar to *traubi, uniformis* and other members of the *Mammilifer* Subgroup, differing particularly in the following characters. *Cibarial Armature.* Cibarial teeth more numerous, about 40; 10 median teeth narrow, with finely pointed apices, lateral teeth coarser with abruptly pointed or blunt apices. *Thorax. Mep* with a row of 5, 6 pale, weak, hairlike setae adjacent to posterior border of *stp,* clearly dorsad of lower *mep* bristle; *ppn* with a few to several scattered, narrow, linear, pale scales cephalad of posterior bristles. *Legs, Wing* and *Abdomen.* Essentially similar to *traubi.*

MALE (Fig. 32). In general as described for female. *Palpus.* Usually as long as proboscis, sometimes slightly shorter or longer; segment 3-5 with a few short bristles on its apices. *Antenna.* Flagellum moderately to densely long plumose; modified tuft of setae present only on flagellomeres 5-8; F-5 with a minute inconspicuous tuft of 3 very short yellowish setae among dense whorl of long hairs; F-6, 7 with poorly developed tufts of few weak curled setae; F-8 with a prominent tuft of 4, 5 stout, long, gently curved setae which are proximally fused, distally spread out, as long as the combined length of 2-3 flagellomeres.

MALE GENITALIA (Fig. 32). As figured; exceedingly similar to *traubi* in the phallosome, proctiger and distimere, differing particularly in the following. *Basimere.* Inner tergal surface with a row of 5, 6 submarginal setae; marginal setae very weak and rather sparse. *Subapical Lobe.* Accessory setae in group *d-f* stronger, more flattened, 2 with distinct serrate margin in subapical portion; leaflet g_1 short, narrow, lanceolate.

PUPA. Abdomen: 2.7 mm. Paddle: 0.70 mm. Trumpet: 0.55 mm; index 10. As figured for *traubi* (Fig. 30). Cephalothorax and abdomen deep yellow to brown. *Trumpet.* Dark brown and moderately long. *Cephalothorax.* Seta 1-C usually triple (2-3); 5-C usually 4-branched (3-5); 8, 9-C usually double (1-2). *Metanotum.* Seta 10-C usually double (2-3); 11-C double; 12-C double or triple. *Abdomen.* Seta 5-IV usually triple (3-4), 1.0-1.5 times as long as segment following; 5-V double, as long as 5-IV; 5-VI double, 0.5 of the length of segment following; 6-III, IV usually double; 6-V-VI single; 9-VII usually 4 branched (3-5); 9-VIII 7-10 branched. *Paddle.* Pale whitish to almost transparent except for yellow midrib and external margin of outer part.

LARVA. Head: 0.65 mm. Siphon: 1.7 mm; index 10. Saddle: 0.34 mm; siphon/saddle ratio 4-6. Very similar to and as figured for *traubi* (Fig. 31), differing from it particularly in the following. *Head.* Seta 1-C more slender, with or without accessory lateral spines. *Thorax.* Lightly spiculate, spicules apparently stronger and denser, more distinct. *Abdomen.* Setae 1-III-VI

stronger, 0.5-1.0 of 6-III-VI; 6-III, IV usually triple (2-3); 6-V double or triple; 6-VI usually double (1-2). Comb scales more numerous, 50 or more. Saddle with several strong sharp spicules on posterior caudal margin. *Siphon.* Subventral tufts 4, 5 branched each, first proximal pairs strongest, about 2 times as long as siphonal width at point of attachment, next 3 pairs gradually shorter and weaker.

TYPE-DATA. Holotype ♂*, Los Banos, *(Luzon)*, PHILIPPINES, 28 Jul 1915 (USNM; Cat. No. 56984).

DISTRIBUTION. Malaysia (N. Borneo) and the Philippines. 91 specimens examined: 50♂, 37♀, 34 L; 57 with associated immature skins (3 p, 54 lp).

MALAYSIA. *Sabah:* Sandakan Bay, Sapagaya Lumber; 1♂.

PHILIPPINES. *Luzon:* Los Banos (type-locality); Baguio; Munoz (central Luzon); San Jose; Subic Naval Base; Zambales; Mt. Makiling; Laguna; Dalton, N. Vizcaya; *Mindoro:* San Jose; *Palawan:* Princesa; Mt. Malino; Irahnan River; *Samar:* Osmena; *Leyte:* Tacloban; Jolo Island: Indanan; 49♂, 37♀, 34 L, 3 p, 54 lp.

TAXONOMIC DISCUSSION. *Culex lavatae* is one of the most common *Lophoceraomyia* in the Philippines. The additional new record of *lavatae* from Sabah based on a male is probably correct as this specimen agrees well with those from the Philippines in every feature of the antenna and genitalia. Although *lavatae* is widespread among the Philippine Islands, there is, however, no indication of local differentiation among the material I have examined.

All stages of *lavatae* can be readily separated from other members of the *Mammilifer* Subgroup as indicated in the above diagnosis and in the keys. Its affinity is closest to *traubi* from which it can be differentiated in the male antenna by the reduction in the size and the number of setae of the modified tufts of flagellomeres 5-7, in the pupa by the double seta 11-C and in the larva by the double seta 6-VI and the stronger spicules on the posterior caudal margin of the saddle. The adults of both sexes of *lavatae* are distinct from all other members of the *Mammilifer* Subgroup in the presence of a row of weak, hairlike setae dorsad of the lower *mep* bristle.

BIONOMICS. The immatures of *lavatae* largely came from the collections made in tree holes in the mountain areas of the Philippine Islands. In Luzon, larvae have also been found in discarded tin cans; wood barrel and used tires. The elevation ranges from 100 to over 1000 m. Most adults from the Philippines were obtained from rearing the pupae and larvae. The single male from Sabah, Malaysia, apparently came from a general field catch.

mammilifer complex

28. *CULEX (LOPHOCERAOMYIA) MAMMILIFER* (LEICESTER)
(Figs. 34, 35)

Lophoceratomyia mammilifer Leicester 1908: 128 (♂, ♀).

Culex (Lophoceratomyia) mammilifer (Leicester), Edwards 1922a: 281 (♂, key); Barraud 1924: 43 (♂*); Edwards 1928: 276 (L); Edwards 1932: 198 (taxonomy); Barraud 1934: 374 (♂*, L); Baisas 1935: 174 (♂*).

Culex (Lophoceraomyia) mammilifer (Leicester), Bohart 1945: 75 (distribution); Mattingly 1949: 227 (L, key); Colless 1965: 287 (♂*, ♀, L*); Delfinado 1966: 109 (♂*, P*, L*); Bram 1967a: 93 (♂*, L*, P); Baisas 1974: 114 (♂, ♀, P, L).

Culex (Lophoceratomyia) chiungchungensis Hsu 1963: 231 (♂*, L*); Colless

1965: 287 (synonymy).

FEMALE. Wing: 2.8-3.0 mm. Forefemur: 1.3-1.4 mm. Proboscis: 1.6 mm. Essentially conforming to the *Mammilifer* Group and Subgroup; usually small, slender species, with the following diagnostic features. *Head*. Vertex with rather broad, ovate, pale, decumbent scales forming distinct ocular line anteriorly; decumbent scales in center narrow, linear and usually entirely dark; erect scales slender, entirely dark; lateral patch of broad scales whitish, very distinct. Strong labial basal setae of proboscis about 0.5 of palpal length. *Cibarial Armature* (Fig. 34). Cibarial bar with a concave row of about 34 elongate teeth, 4 median teeth fine and apically pointed, lateral teeth coarser, apically blunt or abruptly pointed. *Thorax*. One lower *mep* bristle present. *Legs*. Anterior surface of hindfemur with a broad pale stripe extending from base to almost at apex. *Abdomen*. Terga entirely blackish,sterna pale whitish.

MALE (Fig. 34). In general as described for female. *Palpus*. Longer than proboscis by 0.5 to full length of segment 5; segments 4, 5 upturned, with a few short bristles on lateral and mesal surfaces. *Proboscis*. Very slender and thin. *Antenna*. Flagellum moderately plumose; modified tufts of scales and setae present on flagellomeres 5-9; F-5 usually with a distinct tuft of 6-8 dark scales, 3, 4 dorsalmost scales broad, acuminate or apically blunt, as long as the next 2, 3 flagellomeres, followed laterally by 3, 4 narrow, shorter, acute scales of decreasing length, sometimes composed of narrow acute scales only; F-6, 7 with strong, crumpled tufts of curled setae; F-8 with a typical J-hooked tuft of 6, 7 fused setae, some of which are distinctly swollen before tapering into sharp recurved points; F-9 with a prominent tuft of 5-7 dark, long, flattened, bristlelike setae.

MALE GENITALIA (Fig. 34). *Segment IX*. Tergal lobe small, bearing 3 short and weak setae; sternum with an irregular row of 7, 8 strong setae towards caudal margin. *Basimere*. Inner tergal surface with a prominent row of 5-8 strong, sinuous submarginal setae; marginal setae 4-6, all weak, short, widely spaced. *Subapical Lobe*. One of the 3 rodlike setae *a-c* usually curved in middle, separating from the other 2 rods by a distinct gap, sometimes straight and overlapping with other 2 rods; setae *d-f* consist of 1 curved blade and 2, 3 hairlike setae; leaflet g_2 in form of a long, stout blade or rod; leaflet g_1 broad, acuminate; seta *h* strong. *Distimere*. Slender, with distinct crest of fine spicules extending from apex to near middle of curvature; ventral tiny seta present, dorsal one absent; subapical claw short and small. *Phallosome*. Strongly resembling *impostor* and members of the *traubi* complex; internal process of lateral plate long, projecting beyond apex of external process; external process slender in tergal aspect, with only a few weak denticles on lower tergal surface, sometimes practically bare; apex with a spinose lobe which is broad in lateral aspect and apparently not constricted at base. *Proctiger*. As figured, essentially similar to other members of the *Mammilifer* Subgroup; cercal setae 3, 4.

PUPA (Fig. 34). Abdomen: 2.4 mm. Paddle: 0.60 mm. Trumpet: 0.65 mm; index 12-15. Cephalothorax and abdomen yellowish white or cream-colored, rather paler than most forms. *Trumpet*. Darkened, uniformly cylindrical and relatively long; pinna with distinct slit extending to meatus. Complete chaetotaxy as figured, the following setae are diagnostic. *Cephalothorax*. Seta 1-C usually 5-branched (5-6); 5-C weaker than 7-C, usually 6 branched (5-8); 8-C usually double (1-2), 9-C usually triple (2-3). *Metanotum*. Setae 10, 11-C double, 11-C sometimes single. *Abdomen*. Seta 5-IV usually 5 branched (4-7), shorter or as long as segment following; 5-V, VI usually

double (1-2), as long as or slightly longer than segment following; 6-III-VI usually 4 branched (3-7); 9-VII usually triple (2-3); 4-VIII usually triple (2-3); 9-VIII usually 6 branched (5-8). *Paddle*. Pale whitish to almost transparent, midrib lightly to moderately infuscate.

LARVA (Fig. 35). Head: 0.70 mm. Siphon: 1.2-1.9 mm; index usually 10, 11 (7-12). Saddle: 0.27 mm; siphon/saddle ratio 5. Complete chaetotaxy as figured; distinctive particularly in the following. *Head*. Integument varying from pale whitish to yellowish; seta 1-C dark, slender, simple, spiniform; 4-C single, 1.5-2.0 times as long as distance between bases of the pair; 5-C usually double (2-3); 6-C double. Antennal shaft entirely pale except for basal dark ring. *Thorax*. Spiculation absent or not developed; seta 7-P usually double (2-3); 8-P double, subequal to 7-P; 14-P single; 1-M single, as long as or longer than 3-M; all major setae in pleural group lightly or moderately pigmented. *Abdomen*. Spiculation absent; setae 6-I, II triple; 7-I double; 1-III-VI usually triple (3-4); 6-III usually 4 branched (3-4); 6-IV-VI 3, 4 branched, sometimes 5. Comb scales 30-40, more or less subequal in size, each with rounded apical fringe of evenly fine spicules. Saddle pale yellowish, sometimes darker; seta 2-X with 1 short and 1 long branch; 4-X with 6 pairs of setae; anal gills about as long as saddle. *Siphon*. Relatively long and thin; pigmentation varying from pale whitish to light yellowish, sometimes darkened in the middle; pecten teeth 10-16, larger teeth barbed with 6, 7 graded denticles, basal denticle not distinctly differentiated; subventral weak, subequal, usually 3 pairs, sometimes 4; single or double each, as long as or slightly longer than siphonal width at point of attachment; median caudal filament of spiracular apparatus developed.

TYPE-DATA. Lectotype ♂* with slide of antenna and genitalia, Raub, *Pahang, Malaya* [MALAYSIA], larva from pools in jungle path, 5 Jan 1904, G. F. Leicester (BMNH; selection of Colless 1965: 287).

DISTRIBUTION. India, Sri Lanka, China, Thailand, Malaysia, Indonesia and the Philippines. 200 specimens examined: 119♂, 49♀, 32 L; 72 with associated immature skins (13 p, 59 lp).

SRI LANKA. Suduganga, 2♂, 1♀.

THAILAND. *Chiang Mai:* Doi Sutep, Suan Kwi Nin; Chiang Dao Mtn.; *Lampang:* Ngao; Ban Rong Na; Ban Pha Daeng; *Nakhon Ratchasima:* Ban Tha Maprang; *Kanchanaburi:* Huai Mae Nam Noi; Ban Sai Yok; Huai Bong Ti; Khao Sung; *Chanthaburi:* Khao Sai Dao; *Nakhon Si Thammarat:* Chaung Khao; *Ranong:* Khao Hin Chang; *Phuket:* Khao Prathin; Ban Khian; *Yala:* Yala Bong; *Narathiwat:* Khao Lau; 30♂, 5♀, 18 L, 9 p, 12 lp.

MALAYSIA. *Peninsular Malaysia - Selangor:* Rantau Panjang; Ulu Gombak; *Pahang:* Gunong Benom; Merapoh; Mela K. Lipis; *Perak:* Chior F. R.; 22♂, 16♀, 2 p, 6 lp. *Malaysia* (N. Borneo) - *Sarawak:* Kuching; *Sabah:* Tawau; Kota Kinabalu; Sandakan Bay, Sepilak F. R.; Beaufort; 14♂, 8♀, 5 lp.

INDONESIA. *Sumatra:* Bengkoelen; *Java:* Djakarta; 6♂.

PHILIPPINES. *Luzon:* Subic Naval Base; Malawin Creek, Mt. Makiling; *Mindoro:* San Jose; *Palawan:* Iwahig; Iraknam; Balshahan River; *Leyte:* Dagami; Lagolago Baybay; *Samar:* Osmena; *Mindanao:* Gingoog, Ori Missamis; Lanao, Kolambugan; Davao; 45♂, 19♀, 5 L, 1 p, 36 lp.

Additional records from the literature. INDIA, North Bengal; Andaman Is.; Malabar Coast (Barraud 1934: 374); CHINA, Hainan Island (as *chiungchungensis*, Hsu 1963: 231).

TAXONOMIC DISCUSSION. *Culex mammilifer* is one of the most common members of the *Mammilifer* Subgroup and is apparently widespread throughout Southeast Asia and adjacent areas. It can be readily separated from other

members of the *Mammilifer* Subgroup in the male, pupa and larva as indicated in the keys and as described above. The female is difficult to distinguish, but with practice it can be recognized by the predominantly broad, pale decumbent scales on the anterior margin of the vertex and by the presence of a lower *mep* bristle.

Most of the *mammilifer* males from various parts of Southeast Asia essentially agree with the type and topotypic material from Malaysia except in the Philippines where they are very variable and appear to be differentiated into 2 distinct local forms. One of these corresponds well with the typical form in having the modified tuft of antennal flagellomere 5 consisting of some dark broad scales and modified tuft of antennal flagellomere 9 consisting of 5 normal bristlelike setae. This form is apparently widespread throughout the Philippines. The other is known only from Palawan island. It differs markedly from the type form in having only narrow acute scales in the modified tuft of antennal flagellomere 5 and in having modified tuft of antennal flagellomere 9 composed of 6, 7 very strong, flattened bristlelike setae. In the male genitalia, the Palawan form differs slightly from the typical form only in having the rodlike setae *a-c* of the subapical lobe straight and largely overlapping in the distal portion. No associated immature stages of the Palawan males are available for further comparison. Thus, the Palawan form is provisionally treated here as a geographical segregate of *mammilifer* although there is a possibility that it may represent a distinct species.

BIONOMICS. *Culex mammilifer* is one of the few members of the *Mammilifer* Subgroup which utilizes ground pools as its principal breeding habitat. The pupae and larvae have been frequently collected from small pools, particularly puddles and foot prints along stream margins under heavy forest shade. On occasions, they have also been found in rock pools, leaf axils of nipa palm and cut bamboos or bamboo stumps lying close to the ground. These habitats were reported from a broad range of elevation. In Malaysia most of the larval collections came from near the tidal zone along the coast and only a few from inland forests (Colless 1965: 289). The adults mostly came from rearing larvae or pupae but some were also caught by sweeping amongst foliage near the breeding sites. The females are not known to bite man.

29. *CULEX (LOPHOCERAOMYIA) WARDI* NEW SPECIES
(Fig. 36)

FEMALE. Exceedingly similar to *mammilifer*, differing slightly in the following features. *Cibarial Armature*. All cibarial teeth finer and distally tapered into sharp apices. *Legs*. Anterior surface of hindfemur with a broader longitudinal whitish stripe from base to apex.

MALE (Fig. 36). In general as in female, differing from *mammilifer* particularly in the following characters. *Palpus*. Shorter, as long as or slightly shorter than proboscis; segments 4, 5 reduced in length, segment 4 about 0.5 of segment 5. *Proboscis*. Apical 0.50-0.75 with prominent rows of several short setae on lateral and ventral surfaces. *Antenna*. F-5 with a minute and rather inconspicuous tuft of 5-7 short, yellow acute scales, as long as next 2, 3 flagellomeres, followed ventrally by a brushlike tuft of 3, 4 long normal setae; F-9 with a dark tuft of about 7 strong bristlelike setae.

MALE GENITALIA (Fig. 36). Extremely similar to *mammilifer* in the phallosome and proctiger, differing from it in the following features. *Basimere*. Inner tergal surface with a dense double row of 10-12 strong submar-

ginal setae. *Subapical Lobe*. Rod *a* strongly curved at middle, separating from rods *b*, *c* by a wide gap; setae in group *d-f* absent or represented by one short fine seta; leaflet g_2 rodlike, wavy in outline, with apex terminating into a sharp point; leaflet g_1, moderately broad. *Distimere*. Median curvature with a distinct hump on dorsal margin; subapical dorsal surface with more distinct crest of strong spicules.

PUPA. As described and figured for *mammilifer*, differing from it particularly in having apex of paddle slightly produced into a blunt point and generally in darker trumpet, cephalothorax and abdomen.

LARVA. Indistinguishable from *mammilifer*.

TYPE-DATA. Holotype ♂ (212-112) with associated pupal and larval skins and slide of antenna, palpus, proboscis and genitalia, Kanneliya, Galle District, *Sabaragamuwa Province*, SRI LANKA, rock pool, elevation 245 m, 9 July 1975, E. L. Peyton and Y.-M. Huang (USNM); Allotype ♀ (212-6) with associated pupal and larval skins, same data as holotype (USNM); Paratypes: 2 lp♂ (212-5, 10); 5 p♂ (212-100, 105, 106, 108, 109); 5 lp♀ (212-3, 7, 8, 9, 12); 2 p♀ (212-103, 107), same data as holotype and allotype; 1 lp♂ (190-1); 2 lp♂ (197-2, 5); 2 p♂ (197-100, 103); 1 lp♂ (197-3); 2 p♀ (197-101), same locality and collectors as collection No. 212, 8-9 July 1975 (to be deposited in BMNH, Bishop Museum (BPBM) and USNM). This species is named in honor of Dr. Ronald A. Ward, Walter Reed Army Institute of Research, Washington, D. C.

DISTRIBUTION. Known only from Sri Lanka. 75 specimens examined: 39♂, 36♀, 75 with associated immature skins (31 p, 44 lp).

SRI LANKA. *Sabaragamuwa Province:* Galle Dist., Kanneliya; Kalutara Dist., Morapitiya; Ratnapura Dist; Vaddgala; *Western Province:* Colombo Dist., Labugama; Waga; 39♂, 36♀, 31 p, 44 lp.

TAXONOMIC DISCUSSION. *Culex wardi* is known from several specimens recently collected in the southern part of Sri Lanka. It is most closely related to *mammilifer* but is distinct from it in features of the male antenna, palpus and genitalia as indicated above. These differences are striking and constant among the material I have examined. The female and pupa exhibit slight differences as noted above, but the larva is indistinguishable from that of *mammilifer*.

BIONOMICS. This is apparently one of the common species of the subgenus in Sri Lanka. As in *mammilifer*, the immatures have frequently been collected in ground pools and rock pools under heavy shade in forests. On one occasion, it was also reported from a bamboo stump. Collections were made at elevations from 200 to 300 m.

30. *CULEX (LOPHOCERAOMYIA) DEMISSUS* COLLESS
(Figs. 37, 38)

Culex (Lophoceraomyia) demissus Colless 1965: 296 (♂*).

Culex (Lophoceraomyia) fuscosiphonis Bram and Rattanarithikul 1967: 14 (♂*, ♀, L*); Bram 1967a: 87 (♂*, ♀, L*). NEW SYNONYMY.

FEMALE. Wing: 3.0 mm. Forefemur: 1.5 mm. Proboscis: 1.7 mm. Exceedingly similar to *traubi*, *uniformis* and *mammilifer*, differing slightly in the following features. *Head*. Vertex with 1,2 rows of narrow clavate decumbent scales which are predominantly pale, forming a narrow ocular line; lateral patch entirely dark or sometimes grayish. *Cibarial Armature*. As in *mammilifer;* cibarial bar with 30-32 teeth. *Thorax*. Upper surface of

ppn with some scattered dark narrow scales cephalad of posterior bristles. One lower *mep* bristle present, weak and pale. *Abdomen*. Sterna dark grayish or slightly paler than terga.

MALE (Fig. 37). In general as in female. *Palpus*. As long as proboscis. *Antenna*. Flagellum moderately plumose; modified tufts of setae present on F-5-9; F-5 with a small and inconspicuous tuft of 3, 4 short acute setae, as long as 1 flagellomere in length, preceded dorsally by 1 long normal seta and 2 other fine setae; F-6, 7 with weak crumpled tufts of curled and apically twisted setae; F-8 with a smoothly curved tuft of 6 dark, fused setae; F-9 with 3-6 dark, bristlelike setae; F-10 with or without 1 long, hairlike seta distad of normal whorls.

MALE GENITALIA (Fig. 37). *Basimere*. Inner tergal surface with 2 irregular rows of 10 strong submarginal setae associated with several other short setae; marginal setae numerous, strong, as in *traubi*. *Subapical Lobe*. Rods *a*-*c* largely overlapping in distal portion; leaflet g_1 narrow, acuminate; leaflet g_2 in form of a broad pointed blade; seta *h* 1, sometimes 2. *Distimere*. Subapical dorsal surface with a weak crest of few sharp spicules, not extending to middle of curvature. *Phallosome*. External process with 1, 2 rows of strong denticles on tergal surface; internal process prominent, projecting beyond apical lobe of external process. *Proctiger*. Essentially as described for *traubi* and *mammilifer*.

PUPA (Fig. 38). Abdomen: 2.5 mm. Paddle: 0.65 mm. Trumpet: 0.5-0.7 mm; index 12-14. Cephalothorax and abdomen dark brown or deep yellow. *Trumpet*. Slender and long, dark brown, much darker than underlying integument; meatus weakly spiculate or smooth; pinna without slit extending to meatus. Complete chaetotaxy as figured, the following are diagnostic. *Cephalothorax*. Seta 1-C usually double (2-3); 5-C 3, 4 branched, as long as 7-C; 8, 9-C double. *Metanotum*. Setae 10, 11-C usually double (1-3). *Abdomen*. Seta 5-IV usually double or triple (2-4), 1.5 times as long as segment following; 5-V single, 2 times as long as segment following; 5-VI single, as long as segment following; 6-III, IV double; 6-V single or double; 6-VI usually single (1-2); 9-VII 4, 5 branched; 4-VIII double; 9-VIII usually 9 branched (6-10). *Paddle*. Very broad, external basal margin of outer part distinct, dark-pigmented, midrib moderately pigmented, inner part lightly darkened in apical portion, the rest pale whitish.

LARVA (Fig. 38). Head: 0.74 mm. Siphon: 2.0-2.2 mm; index 18-19. Saddle: 0.27 mm; siphon/saddle ratio 8-9. Essentially conforms to the *Mammilifer* Subgroup, with the following diagnostic features. *Head*. Pigmentation yellowish with considerable amount of brownish tinge; seta 1-C dark, slender and simple; 5, 6-C double. Antennal shaft entirely dark. *Thorax*. Spiculation absent or sometimes present, very poorly developed; 7-P double; 8-P single, varying from as long as 3-P to nearly as long as 7-P. *Abdomen*. Spiculation absent; setae 6-I, II and 7-I very dark, strong and stout; 6-I, II triple; 7-I double; 6-III-V triple; 6-VI double or triple; 1-III-V usually triple (3-4); 1-VI 4, 5 branched; the remaining setae very weak and rather inconspicuous. Comb scales narrow, numerous, about 47; posterior scales elongate, with even fringe of fine spicules largely restricted to apex. Saddle dark brown, concolorous with siphon, posterior caudal margin lightly spiculate, spicules minute and very fine; seta 2-X double. *Siphon*. Very dark brownish, slender and long; distal portion lightly tapered or uniformly thick; 10 pecten teeth, larger distal teeth with 1, 2 strong basal denticles and 3, 4 weak distal denticles; subventral tufts relatively weak and short, 4 pairs, all of which are subequal, double or triple, as long as or slightly longer than siphonal width at points of attachment;

median caudal filament not developed.

TYPE-DATA. (1) *Culex (L.) demissus* Colless, Holotype ♂* with slides of antenna (CH 164) and genitalia (CT 585), Ulu Gombak, *Selangor, Malaya* [MALAYSIA], 13 May 1957, D. H. Colless (ANIC); (2) *Culex (L.) fuscosiphonis* Bram and Rattanarithikul, Holotype ♂* (PU4-102) with slide of antenna and genitalia, Muang, *Phatthalung Province*, THAILAND, from a tree hole in a primary forest, 15 Oct. 1964, S. Chumchulcherm (USNM, No. 69185).

DISTRIBUTION. Known only from Thailand and Peninsular Malaysia.
21 specimens examined: 3♂, 4♀, 14 L; 5 with associated immature skins (4 p, 1 lp).

THAILAND. *Khon Kaen:* Phu Wiang; *Trang:* National Park Forest; *Phatthalung:* Muang; *Nakhon Si Thammarat:* Ban Thuen Lek; Ban Sai Kae; 2♂, 4♀, 14 L, 4 p, 1 lp.

MALAYSIA. *Peninsular Malaysia - Selangor:* Ulu Gombak (type-locality) 1♂ (holotype).

TAXONOMIC DISCUSSION. I have checked the males of *fuscosiphonis* Bram and Rattanarithikul (1967: 14-6) against the holotype male of *demissus* Colless (1965: 296-7) and found that they agree in every essential detail of the antenna and genitalia. On this basis, it appears that the 2 species are conspecific and as proposed above, I am synonymizing *fuscosiphonis* with *demissus*.

Culex demissus resembles *mammilifer* in the type of male phallosome and the presence of modified tufts of setae on flagellomeres 5-9 of the male antenna and with the latter apparently falls into a complex (the *mammilifer* complex). It can be readily separated from *mammilifer* in all stages as indicated in the keys and as described above. The whole larvae from Trang and Nakhon Si Thammarat and Patthalung in southern Thailand are essentially similar, but those from Khon Kaen in northeastern Thailand are slightly different in having a shorter siphon and stronger siphonal tufts. It appears that the Khon Kaen larvae probably belong to a different species. However, in the absence of associated adult males, this record cannot be definitely confirmed.

BIONOMICS. *Culex demissus* is apparently rare. The specimens from Thailand all came from the collections made in tree holes in forests. The single male from Peninsular Malaysia was reared from a larva found in a jungle tree hole (Colless 1965: 297).

ganapathi complex

31. *CULEX (LOPHOCERAOMYIA) GANAPATHI* COLLESS
(Figs. 39, 40)

Culex (Lophoceraomyia) ganapathi Colless 1965: 294 (♂*, ♀, L*); Bram 1967a: 90 (♂*, ♀, L*).

FEMALE. Wing: 2.9 mm. Forefemur: 1.4 mm. Proboscis: 1.7 mm. Rather small, slender species; in general extremely similar to *traubi;* differing slightly in paler coloration and in the following. *Head.* Narrow decumbent scales in center of vertex predominantly pale; erect scales more slender; lateral patch of broad scales more conspicuous. *Cibarial Armature.* Cibarial teeth coarser, 30-32. *Thorax.* Mesonotal integument paler; scales finer, darker than underlying integument. Upper surface of *ppn* with some scattered narrow dark scales cephalad of posterior bristles. Pleuron paler than mesonotum; lower *mep* bristle stronger. *Legs.* Anterior surface of hindfemur with

narrower pale stripe, not extending dorsad in basal 0.5.

MALE (Fig. 39). As described by Colless (1965: 294) and Bram (1967a: 90). *Palpus*. Equal to or slightly longer than proboscis. *Proboscis*. Slender and uniformly thin. *Antenna*. Pedicel with a rather broadly blunt spiculose prominence on inner dorsal surface; flagellar whorls weakly to moderately plumose; F-5 with a distinct tuft of 5, 6 narrow scales, 1-3 dorsalmost scales dark, lanceolate, as long as next 2, 3 flagellomeres; followed laterally by 3, 4 yellowish brown or golden scales of decreasing length; F-6, 7 with strong crumpled tufts of curled setae, as in *traubi*; F-8 with a slender, subapically sinuous or gently hooked tuft of 7 fused setae; F-9 without differentiated bristle-like setae.

MALE GENITALIA (Fig. 39). As figured. *Segment IX*. Tergal lobe with 2-4 tiny setae; sternum usually with 2-4 strong setae towards caudal margin. *Basimere*. Inner tergal surface with a row of 4-6 moderately strong submarginal setae, rather widely spaced; marginal setae weak and sparse. *Subapical Lobe*. Rodlike setae *a-c* subequal, largely overlapping; setae *d-f* consist of 3, 4 curved blades; leaflets g_1, g_2 moderately strong; seta *h* strong and apically hooked. *Distimere*. Subapical dorsal surface without crest of spicules, subapical claw very short and small. *Phallosome*. External process relatively broad in tergal aspect, upper tergal surface with 15-17 strong denticles in 2, 3 close-set rows, apical spiculose lobe elongate, with distinct basal stalk, apparently situated sternad; internal process very strong, but not projecting beyond apex of external process. *Proctiger*. Apical crown large or medium-sized, cercal setae 3.

PUPA (Fig. 39). Abdomen: 2.4 mm. Paddle: 0.55 mm. Trumpet: 0.7 mm, index 15-20. Cephalothorax and abdomen varying from cream-colored to yellow with variable amount of brownish tinge. *Trumpet*. Dark, thin and very long, apparently longest among the members of the *Mammilifer* Subgroup; meatus very weakly spiculate or smooth, especially in apical 0.5 distad of median annulation; pinna very narrow, without slit extending into meatus. Complete chaetotaxy as figured, the following setae are diagnostic. *Cephalothorax*. Seta 5-C remarkably strong and long, at least 2 times as long as 7-C, usually triple (2-4); 8, 9-C usually double (2-3). *Metanotum*. Seta 10-C usually double (1-3); 11-C always single. *Abdomen*. Seta 3-I-III usually single (1-2); 5-IV-VI very strong, 1.5-2.0 times as long as segment following; 5-IV usually double (2-3); 5-V single or double; 5-V always single; 6-III, IV weak, usually triple (2-3), 6-V, VI stronger, usually double, sometimes triple; 9-VII, VIII strong, subequal, 9-VII 3-7 branched; 9-VIII 7-12 branched; 4-VIII usually double (1-3). *Paddle*. Entirely pale whitish; midrib lightly to moderately darkened.

LARVA (Fig. 40). Head: 0.70 mm. Siphon: 1.3-2.0 mm; index 8-11. Saddle: 0.3 mm; siphon/saddle ratio 5. Complete chaetotaxy as figured, distinctive in the following. *Head*. Cream-colored or yellowish; seta 1-C simple or with lateral spines, lightly to strongly swollen in middle before tapering into a sharp point, sometimes forked into 2, 3 apical spines; 5, 6-C double. Antennal shaft pale in the middle, darkened at extreme base and beyond seta 1-A. *Thorax*. Spiculation light to moderate, spicules minute, usually not very dense; seta 7-P usually double (2-3); 8-P single, subequal to 7-P. *Abdomen*. Spiculation absent; setae 6-I, II and 7-I dark, stout; 6-I, II triple; 7-I double; 1-III-VI usually triple (2-3); 6-III-VI triple. Comb scales 32; posterior scales larger than anterior ones, all with rounded apical fringe of evenly fine spicules. Saddle same color as siphon or sometimes darker; posterior caudal margin lightly spiculate; seta 2-X double. *Siphon*. Variable in length; pigmentation

usually yellowish, concolorous with head capsule, sometimes brownish; pecten teeth 11-16, larger distal teeth with 7-10 graded denticles, basal denticles usually not strongly differentiated, subventral tufts 4 pairs, sometimes 4.5-5 pairs; 3 proximal pairs strong 3-5 branched each, most proximal pair longest, 4, 5 times as long as siphonal width at points of attachment, next 2 pairs gradually shorter; most distal pairs shortest, 4, 5 branched, about 0.5 of the length of the next proximal pair.

TYPE-DATA. Holotype ♂ with associated larval and pupal skins (0643/3) and slide of genitalia (CT 582), Ulu Langat, *Selangor, Malaya* [MALAYSIA], 10 May 1958 (ANIC).

DISTRIBUTION. Thailand and Malaysia. 403 specimens examined: 226♂, 158♀, 19 L; 293 with associated immature skins (181 p, 112 lp).

THAILAND. *Chiang Mai:* Doi Sutep; *Mae Hong Son:* Ban Pa Chi; Ban Huey Yang; *Tak:* Doi Sam Sao; Khao Salak Phra; Huey Lang Saeng; *Nakhon Ratchasima:* Khao Yai; *Nakhon Nayok:* Khao Yai; Khao Sing To; Kaeng Sa-An; *Kanchanaburi:* Huey Lin Tin; Huey Mae Nam Noi; Ban Sai Yok; Khao Saeng; Chanthaburi: Khao Hin Paeng; Khao Sai Dao; *Ranong:* Kraburi; Ban Chatri; Ban Bang Hin; Khlong Baeng Man; Ban Sami; Khlong Bang Yang; *Phangnga:* Pak Chaung; Thap Wen; Pathum, Nam Tai; Tang Mai; *Trang:* Muang; Phatthalung: Muang; *Nakhon Si Thammarat:* Ban Thuan Lek; *Narathiwat:* Khau Lau; 178♂, 103♀, 6 L, 174 p, 79 lp.

MALAYSIA. *Peninsular Malaysia - Selangor:* Ulu Langat (type-locality); Ulu Gombak; The Gap; Ulu Klang; Ampang F. R. *Pahang:* Bentong Rd.; Gunong Benom; Sungai Temau; *Kelantan:* Bertram; *Perak:* Cameron Highlands; 48♂, 55♀, 9 L, 7 p, 32 lp. *Malaysia - Sabah:* Pensiangan; 4 L, 1 lp (adult ♀ lost).

TAXONOMIC DISCUSSION. *Culex ganapathi* is one of the most common forms of the *Mammilifer* Subgroup with its distribution restricted to Malaysia (particularly Peninsular Malaysia) and Thailand. The male antenna and genitalia appear to be similar to *szemaonensis* as described and figured by Wang and Feng (1964: 37-41) from Yunnan, China. However, as I have not examined the type of the latter, it is not possible to determine whether both forms are conspecific.

The male, pupa and larva of *ganapathi* can be easily confused with *traubi* and the members of the *minor* complex. The male strongly resembles *traubi* in the development of the modified tufts of antennal flagellomeres 5-8, but is different from the latter in having darker, broader and longer acute scales in the modified tuft of flagellomere 5 and in the shape of the modified tuft of flagellomere 8. The male genitalia resemble members of the *minor* complex from which it is differentiated by the presence of 4-6 moderately strong submarginal setae on the basimere and the largely overlapped rodlike setae of the subapical lobe. The pupa can be readily recognized by the very slender and long trumpet; the remarkably strong seta 5-C and the usually single setae 3-I-III. The larva resembles *traubi* in most features of the chaetotaxy but can be distinguished from it by the paler antenna, siphon and saddle, double seta 5-C, triple seta 6-VI and by the poorly differentiated denticles of the pecten teeth.

All larvae of *ganapathi* essentially conform to the above description except for the specimens from Sabah, which differ from the usual form in having denser spicules on the thorax, a darker siphon, presence of 5 pairs of the siphonal tufts and in the development of strong basal denticles of the pecten teeth. Unfortunately, the male associated with this larval form is not available for this study. This form may prove to be distinct, but pending further knowledge of the male, they were tentatively identified as *ganapathi*.

BIONOMICS. The immatures of *ganapathi* have been collected from bamboos and tree holes. They were found more frequently in bamboo than in tree holes. In Thailand, it has also been reported from pandanus axils and ground pools and in Peninsular Malaysia from artificial containers. The records from ground pools are probably in error, perhaps due to contamination. In Peninsular Malaysia, *ganapathi* has been frequently found in association with *minor* (Colless 1965: 295). All adults apparently came from individual or mass rearing the larvae.

32. *CULEX (LOPHOCERAOMYIA) SPICULOSUS* BRAM AND RATTANARITHIKUL (Figs. 41, 42)

Culex (Lophoceraomyia) spiculosus Bram and Rattanarithikul 1967: 3 (♂*, ♀, L*); Bram 1967a: 105 (♂*, ♀, L*).
Culex (Lophoceraomyia) hui Lien 1968: 227 (♂*, ♀, L*). NEW SYNONYMY.

FEMALE. Wing: 3.2 mm. Forefemur: 1.6 mm. Proboscis: 1.9 mm. Medium-sized species with external characters as described for most members of the *Mammilifer* Subgroup, differing from the preceding species in relatively larger size and slightly in the following. *Head*. Decumbent scales of vertex entirely narrow, linear and predominantly yellowish brown; lateral patch of broad scales dingy white; erect scales rather coarser, usually entirely dark, sometime partially pale yellowish on posterolateral area. *Cibarial Armature*. As figured for *mammilifer*, cibarial teeth about 35, 8-10 median teeth narrow and apically pointed, lateral teeth coarser, with truncate or blunt apices. *Thorax*. Mesonotal integument and scales blackish. Lower *mep* bristle present. *Legs*. Anterior surface of hindfemur with a broad whitish stripe, as in *traubi*. *Wing*. Scales on wing veins rather dense. *Abdomen*. Terga black scaled, sterna pale whitish or light yellowish.

MALE (Fig. 41). Similar to *traubi* and *ganapathi* in having modified antennal tufts developed only on flagellomeres 5-8, differing chiefly in the following features. *Palpus*. Longer, exceeding proboscis length by 0.5 to full length of segment 5. *Antenna*. Flagellum densely long plumose; F-5 with a minute tuft of 4-7 dark, short, hairlike setae, all subequal, as long as 1 flagellomere in length; F-6, 7 with slender or weakly developed crumpled tufts of curled setae; F-8 with a prominent tuft of 5, 6 fused setae, which is straight or weakly curved in distal portion; F-9 usually without any modified bristlelike seta, sometimes with 1 weak seta among several long normal setae.

MALE GENITALIA (Fig. 41). As figured; exceedingly similar to *traubi* and *ganapathi*, differing in the following details. *Basimere*. Inner tergal surface with a prominent row of 6-8 moderately strong submarginal setae and 2, 3 rows of several weak marginal setae, submarginals closely spaced, in a linear or irregular row. *Subapical Lobe*. Distal part with several weak, short, hairlike setae associated with setae *d-f*; seta *h* remarkably strong and long; rod *c* clearly separated from *a*, *b* distad; leaflets g_1 and g_2 as in *traubi* and *ganapathi*. *Phallosome*. As in *ganapathi;* internal process distinct, shorter than external process; external process with a distinct spiculate apical lobe sternad and several strong denticles on tergal surface. *Proctiger*. Crown large; cercal setae usually 4.

PUPA. Abdomen: 2.7 mm. Paddle: 0.72 mm. Trumpet: 0.60 mm; index 9-10. As figured for *traubi* (Fig. 30). Pigmentation of cephalothorax

and abdomen brownish or yellowish with considerable amount of brownish tinge. *Trumpet.* Dark brown, relatively thick and long; meatus strongly spiculate distad of median annulation, as in *traubi;* pinna broad and moderately oblique. Diagnostic chaetotaxy as indicated in the key and as in the following. *Cephalothorax.* Seta 1-C usually double (2-3) and weak; 5-C usually triple (2-5), as long as 7-C; 8, 9-C double. *Metanotum.* Seta 10-C usually double (1-3); 11-C single. *Abdomen.* Setae 3-I-III single or double; segment II usually with 1 extra seta (seta 11 of Belkin 1962) on ventral surface; 5-IV 2-4 branched, as long as segment following; 5-V, VI single, 5-V 1.5 times as long as segment following; 5-VI 0.5 of segment following; 6-III-VI weak, subequal, usually double (2-3); 9-VII 3-5 branched, shorter than 9-VIII; 9-VIII 5-8 branched and strongly pectinate. *Paddle.* Rather broad, yellowish white, midrib strong and moderately pigmented.

LARVA (Fig. 42). Head: 0.78 mm. Siphon: 1.4-1.9 mm; index 7-8. Saddle: 0.34 mm; siphon/saddle ratio 4-5. Strikingly differentiated from all members of the *Mammilifer* Subgroup except *uniformis* and *kuhnsi* by the heavily spiculose thorax and abdomen; complete chaetotaxy as figured; differing from the latter 2 species as indicated in the key and in the following additional features. *Head.* No transverse band of spicules at level of ocular bulb on ventral surface; seta 1-C slender, simple and long; 5, 6-C double. Antenna usually entirely dark, sometimes partially pale in middle, spicules rather fine. *Thorax.* Spiculation usually strong and dense, sometimes reduced; individual spicules hairlike and unbranched; seta 8-P strong, subequal to 7-P, single; 7-P usually double (2-3). *Abdomen.* Spiculation as in thorax; setae 6-III usually triple (3-5); 6-IV-VI usually double or triple (2-4); 1-III-VI strong, about 0.5 of 6-III-VI, double or triple (2-4). Comb scales about 40. Saddle dark brown; posterior caudal margin lightly to moderately spiculate, individual spicule short and weak; seta 2-X single. *Siphon.* Yellowish to dark brownish, length variable; pecten teeth 10-15, large distal teeth with 1 strong basal denticle and 6, 7 fine distal denticles; subventral tufts moderately long, 4 pairs, first 3 proximal pairs usually 4 branched each (2-4), 2, 3 times as long as siphonal width at point of attachment, most distal pair 4, 5 branched, 1.5 times as long as siphonal width at point of attachment.

TYPE-DATA. (1) *Culex (L.) spiculosus* Bram and Rattanarithikul, Holotype ♂* (00272-3) with associated larval and pupal skins and slide of antenna and genitalia, Doi Sam Sao, *Tak,* THAILAND, bamboo stump, 30 July 1965, Sumeth Chumchulcherm (USNM; No. 69181); (2) *Culex (L.) hui* Lien, Holotype ♂ (61864.4) with associated larval and pupal skins, Chukou, Fanlu, Chia Hsien, TAIWAN, bamboo stump, 14 May 1961, J. C. Lien (Taiwan Provincial Institute of Infectious Diseases, Taipeh, Taiwan, Republic of China).

DISTRIBUTION. Thailand, Burma, Peninsular Malaysia and Taiwan. 187 specimens examined: 64♂, 32♀, 91 L; 67 with associated immature skins (19 p, 48 lp).

THAILAND. *Chiang Mai:* Doi Sutep; Ban Khun Klang; *Tak:* Doi Sam Sao (type locality); Khao Salak Phra; *Nakhon Nayok:* Khao Yai; *Chanthaburi:* Khao Sai Dao; 58♂, 25♀, 91 L, 19 p, 36 lp.

BURMA. *Rangoon;* 1♂.

MALAYSIA. *Peninsular Malaya - Perak:* Cameron Highlands Rd.; 4♂, 6♀, 10 lp.

TAIWAN. Chia Hsien: Chukuo Fanlu; 1♂, 1♀, 2 lp (as *hui,* Lien 1968).

TAXONOMIC DISCUSSION. The proposed synonymy of *hui* Lien (1968: 227) from Taiwan with *spiculosus* Bram and Rattanarithikul (1967: 3) from Thailand has been based on the comparison of the specimens in the type-series. In

checking 2 paratypes of *hui* against the type and several other topotypic specimens of *spiculosus*, no difference has been found except for the spiculation of the larva which is better developed in *spiculosus* than in *hui*.

Culex spiculosus is morphologically intermediate between *ganapathi* and *traubi*. The male phallosome of *spiculosus* resembles that of *ganapathi* but the larva and pupa are similar to *traubi* in most features of the chaetotaxy. The larva is most diagnostic, particularly in the development of dense spiculation on the thorax and abdomen which is superficially very similar to those of *uniformis* from Sri Lanka and *kuhnsi* from the Philippines. It is quite probable that the record of *uniformis* from Hainan Island, China by Chu (1958: 109-13) is in fact that of *spiculosus*.

BIONOMICS. *Culex spiculosus* is restricted to high elevations in inland mountainous areas. The immatures have been frequently collected from bamboo stumps and occasionally from tree holes under heavy shade of tropical forests. Most of the adults came from rearing the larvae and pupae. In Thailand, several were also caught while resting on vegetation near the breeding sites.

minor complex

33. *CULEX (LOPHOCERAOMYIA) MINOR* (LEICESTER)
(Figs. 43, 44)

Lophoceratomyia minor Leicester 1908: 126 (♂, ♀).
Culex (Lophoceratomyia) minor (Leicester), in part, Edwards 1917: 227 (♂, key); Edwards 1922a: 282 (key); Barraud 1924: 44 (♂*, ♀); Borel 1930: 356 (♂*, ♀, L*); Edwards 1928: 276 (key); Edwards and Given 1928: 352 (L); Edwards 1932: 198 (taxonomy); Barraud 1934: 370 (♂*, ♀); Brug and Bonne-Wepster 1947: 186 (distribution).
Culex (Lophoceraomyia) minor (Leicester), Mattingly 1949: 227 (L, key); Colless 1965: 289 (♂*, ♀, L*); Delfinado 1966: 111 (♂*, ♀); Bram 1967a: 96 (♂*, ♀, L*, in part).
Culex (Lophoceratomyia) plantaginis Barraud 1924: 46 (♂*); Barraud 1934: 372 (♂*, in part). NEW SYNONYMY.
Culex (Lophoceratomyia) nolledoi Baisas 1935: 170 (♂*); Colless 1965: 289 (synonymy).

FEMALE. Wing: 2.9-3.8 mm (average 3.4 mm). Forefemur 1.4-1.9 mm (average 1.8 mm). Proboscis: 1.7-2.2 mm (average 2.1 mm). Usually medium size (wing length over 3.0 mm), sometimes small or rather large; in general very similar to most members of the *Mammilifer* Subgroup from which it cannot be distinguished with certainty. *Head*. Decumbent scales on dorsum of vertex very narrow, linear and pale along upper eye margin, predominantly dark or yellowish brown in center and on occiput; erect scales entirely blackish and rather coarse; lateral patch of broad scales whitish or grayish, fairly distinct. Palpus black scaled, 0.2 of proboscis length, segment 4 longest, about 3 times as long as the combined length of segment 1-3. Proboscis black and relatively thick; longest labial basal seta about 0.5 of palpal length. *Cibarial Armature*. Cibarial bar with a concave row of 35, 36 teeth; 8 median teeth narrow, fine with sharply pointed apices, lateral teeth coarser with blunt or truncate apices. *Thorax*. Integument of mesonotum deep chestnut brown or black; scales rather narrow, short, fine and entirely black; dorsocentral, supra-alar and scutellar bristles very strong. Upper

surface of *ppn* without any setae or scales cephalad of posterior bristles. Pleuron paler or same color as mesonotum; scales practically absent; *ppl* with 1, 2 strong dark bristles and a few other weak setae; 1 lower *mep* bristle present. *Legs*. Anterior surface of hindfemur with moderately broad pale stripe from base to apex, rest of legs blackish, without any marked coloration. *Wing*. Scales on all wing veins very narrow, moderately to very dense. *Abdomen*. All terga black scaled; sterna usually pale yellowish or whitish, sometimes as dark as terga.

MALE (Fig. 43). As described by Colless (1965: 289-91). *Palpus*. Slender, varying from as long as or longer than proboscis by 0.5-1.0 of segment 5; segments 4 and 5 and apex of segment 3 with only a few short bristles. *Proboscis*. Uniformly thick throughout entire length, setae widely scattered and sparse, largely restricted to lateral surface. *Antenna*. Spiculose prominence on inner dorsal surface of pedicel strong, distinct, with apex more or less pointed; flagellar whorls moderately to densely long plumose; modified tuft of setae developed on flagellomeres 5-9; F-5 with a small, rather inconspicuous tuft of 3-5 yellow or golden spinelike setae which are subequal, as long as 1 flagellomere, preceded dorsally by 2-4 long normal setae; F-6 with a strong crumpled tuft of heavily curled and subapically twisted setae; F-7 with a mesal tuft of 5-7 narrow, short, acute spinelike setae in addition to 2 other usual tufts on lateral and ventral surfaces; F-8 with a thick, sigmoid or J-hooked tuft of 6, 7 fused setae and a close-set row of 6, 7 short bladelike setae laterad; F-9 with a tuft of 3, 4 dark bristlelike setae.

MALE GENITALIA (Fig. 43). *Segment IX*. Tergal lobe bears 3-5 moderately strong setae; sternum with 1, 2 irregular rows of 4-10 strong setae towards caudal margin. *Basimere*. Well sclerotized; inner tergal surface with 6, 7 strong sinuous submarginal setae in a close-set row which is slightly diverging towards lateral tergal surface; 6-9 marginal setae weak, widely spaced. *Subapical Lobe*. Most proximal rod or seta *a* strongly curved in middle, separated from setae *b*, *c* by a wide gap; setae *b*, *c* gently curved or straight, with bases overlapped with those of setae *d*-*f* in distal part; leaflet g_1 broad, apex acuminate; g_2 long, bladelike; seta *h* strong. *Distimere*. Normal; subapical dorsal surface without crest of spicules; subapical claw short and small; dorsal and ventral tiny seta present, dorsal seta distad of ventral. *Phallosome*. Well sclerotized; internal process strong, simple, curved tergad and not projecting beyond apex of external process; external process with 2, 3 rows of 15-20 strong denticles on upper tergal surface and a spiculose apical lobe sternad, inner surface with variable number of toothlike marks. *Proctiger*. Crown dark, large, consisting of numerous strong spinelike spicules; paraproct well sclerotized and moderately pigmented; cercal sclerite broad, poorly or moderately sclerotized and pale; cercal setae 3-5, distinct.

PUPA (Fig. 43). Abdomen: 3.2 mm. Paddle: 0.70 mm. Trumpet: 0.80 mm; index 12. Cephalothorax and abdomen varying from pale, cream-colored, yellowish to dark brownish. *Trumpet*. Dark brown, rather thick and long; apical portion distad of proximal annulation of meatus weakly to moderately spiculated; pinna moderately broad oblique, without slit extending to meatus. Complete chaetotaxy as figured, diagnostic features as in the key. *Cephalothorax*. Seta 1-C usually double (2-4); 5-C subequal to 7-C, usually double (2-4); 7-9-C double. *Metanotum*. Setae 10-C usually double (1-3); 11-C usually double (1-2). *Abdomen*. Setae 3-I-III usually double (1-2); 5-IV, V 1.5-2.0 times as long as segment following; 5-IV usually double (2-4); 5-V usually double (1-2); 5-VI slightly shorter than segment following, usually single (1-2);

6-III-VI usually double (1-3); 9-VII subequal to 9-VIII, usually triple (2-4); 9-VIII 6-9 branched. *Paddle.* Very broad and pale, basal external margin of outer part distinct, apical margin indistinct, midrib lightly pigmented; setae 1, 2-P present; 1-P strong, dark; 2-P weak, minute, rather inconspicuous.

LARVA (Fig. 44). Head: 0.78 mm. Siphon: 1.7 mm; index 8, 9. Saddle: 0.30 mm.; siphon/saddle ratio 5. Complete chaetotaxy as figured, diagnostic characters as in the key; setae very variable in color, length and thickness. *Head.* Yellowish to light brownish; seta 1-C simple, slender and moderately long; 5-C usually double (1-3); 6-C double. Antenna variable in color, usually pale in the middle, dark at base and beyond insertion of seta 1-A, or sometimes uniformly dark; spicules strong and dark. *Thorax.* Unspiculate or lightly spiculate; spicules minute, dotlike, widely spaced and rather indistinct; setae 1-3-P single; 4-P usually double (2-3); 5, 6-P single; 7-P double, 8-P single, subequal to 7-P; 14-P double. *Abdomen.* Spiculation absent except on segment VIII; setae 6-I, II and 7-I usually very dark and stout, all double; 6-III-VI double or triple; 1-III-VI and 13-III-V usually triple (2-4), varying from 0.25-0.75 of length of 6-III-VI. Comb scales 35-50; anterior scales with normal fringe of evenly fine spicules; posterior scales elongate, with apical fringe terminated into a stout median spine. Saddle yellowish to brownish, posterior caudal margin lightly spiculate; seta 2-X triple; anal gills 1.5 times as long as saddle length. *Siphon.* Very slender, more or less tapering distally; pigmentation variable, usually yellow, concolorous with head capsule, sometimes light brown; pecten teeth 11-16, larger distal teeth barbed with 7, 8 denticles, 1, 2 basal denticles usually enlarged and strongly differentiated from distal denticles; subventral tufts weak and rather short, 3 pairs, usually 3, 4 branched (3-5) each; first proximal pair strongest, 1.0-1.5 times as long as siphon width at point of attachment, the remaining distal pairs gradually shorter; median caudal filament of spiracular apparatus present, well developed.

TYPE-DATA. (1) *Lophoceratomyia minor* Leicester, lectotype ♂* with attached antenna and genitalia mount, Ulu Klang, Kuala Lumpur, *Selangor*, Malaya [MALAYSIA], 14 October 1903, G. F. Leicester (BMNH; selection of Colless 1965: 289); (2) *Culex (Lophoceratomyia) plantaginis* Barraud, Lectotype ♂* with slide of antenna and genitalia, marked as type by Barraud, Koti, near Kalka (Kalka-Simla road), Himalaya foothills, INDIA, August 1923, P. J. Barraud (BMNH; present selection); (3) *Culex (Lophoceratomyia) nolledoi* Baisas, Type ♂, ♀ (non-existent), Kolambugan, Lanao Province, *Mindanao*, PHILIPPINES, 31 July 1934, Francisco Guinto (Bureau of Health, Manila; apparently lost or destroyed).

DISTRIBUTION. India, Thailand, Malaysia, Indonesia and the Philippines. 676 specimens examined: 332♂, 271♀, 72 L; 359 with associated immature skins (147 p, 212 lp).

INDIA. *Western Himalayas:* Koti near Kalka; 1♂ (as *plantaginis* Barraud); Andaman Is.; 2♂.

THAILAND. *Nakhon Ratchasima:* Koraj, Pachong; Khao I-Phrom; *Nakhon Nayok:* Huey Tha Thong; *Chon Buri: Sriracha; Chanthaburi:* Ban Chak Yai; Khao Hin Phaeng; Khao Sai Dao; Khlong Ka Ting; *Trat;* Koh Chang; Ban Cham Rung; *Phattalung:* Muang; *Ranong:* Kraburi: Khlong Bang Yang; *Nakhon Si Thammarat:* Ban Thuen Lek; *Trang:* Gun Tung; *Songkhla:* Tone Nga Chang; 103♂, 89♀, 15 L, 101 p, 69 lp.

MALAYSIA. *Peninsular Malaysia*-Selangor: Ulu Gombak; Ulu Langat; Bt. Ulu Bakau; Bt. Kutu; *Pahang:* Pulau Tioman; Bentong Rd., M. S.; Kg.

Janda Baik; Gunong Benom; Sungai Temau; Fraser's Hill; *Perak:* Kg. Sq. Itek; *Perlis:* Kg. Wang Kelian; *Kedah:* Kg. Bagan; *Malaysia-Sarawak:* Tebangan; *Sabah:* Mt. Kinabalu; Beaufort; Tenom; 110♂, 112♀, 31 L, 38 p, 75 lp.

INDONESIA. *Kalimantan:* Tarakan; *Java:* Djakarta; *West Irian:* Humboldt Bay; 6♂, 5♀.

PHILIPPINES. *Luzon:* Tayabas; Trinidad Mt. Province; Dalton, N. Vizcaya; Subic Naval Base; *Mindoro:* San Jose; *Palawan:* Mt. Malinao; Irahnan River; Iwahig; Puerto Princesca; *Leyte:* Lagolago Baybay; *Camarines Sur.* Mt. Isarog; *Samar:* Osmena; Calaccad; Sohoton; *Jolo Jolo Is.*; 110♂, 65♀, 27 L, 8 p, 68 lp.

Additional records from the literature: BURMA (Barraud 1934).

TAXONOMIC DISCUSSION. *Culex minor* has been recorded from Malaysia, southern Thailand, Indonesia and the Philippines where it is one of the most common forms of the *Mammilifer* subgroup. Elsewhere in Southeast Asia and other parts of the Oriental region, it appears to be completely replaced by *bicornutus* to which it is most closely related. The proposed synonymy of *plantaginis* Barraud from India with *minor* is only tentative but appears to be correct since the type-male which I examined and designated as a lectotype perfectly agrees with *minor* in the characters of antenna, proboscis and genitalia. As described by Barraud (1924: 46; 1934: 372) and subsequently discussed by Colless (1965: 291), *plantaginis* differs from *minor* in having basal pale bands on the abdominal terga. However, as the type was mounted in balsam and other specimens in the type-series were found to be a mixture of different species, including *bicornutus*, it has not been possible to evaluate the taxonomic importance of this character. Further study of additional topotypic material is required in establishing the identity of *plantaginis*, but for the present, it appears justified to consider it as a synonym of *minor*. There is also a possibility that it may be conspecific with *bicornutus*, but without additional material, this problem cannot be resolved. I have examined the larvae from Nepal, tentatively identified as *plantaginis* by Peters and Dewar (1956: 44) and found them to be *Culex (Culex) whitei*.

The adult males of *minor* which I have examined from several localities listed in the distribution data agree well with the type and topotypic specimens from Malaya. The larvae and pupae are subject to considerable variation in size, pigmentation and chaetotaxy. Those from rock pools are usually darker and exhibit stronger setae than the ones from tree holes or bamboos but all essentially conform to the diagnostic chaetotaxy as described and illustrated. The larvae from rock pools usually differ from those in container habitats in having setae 1 and 6-III-VI stronger and more branched. The development of 1, 2 stout basal denticles in the larval pecten teeth as described by Colless (1965: 290) is especially very diagnostic of the *minor* populations in Malaya and Sabah but has been found to be subject to a considerable variation, overlapping with *bicornutus* in the populations from Thailand and the Philippines. In all the material from the Philippines which I have examined, the males are typical of *minor* but the larvae show evenly graded denticles of the pecten teeth as in *bicornutus*.

Among the members of its complex, *minor* most closely resembles *bicornutus* and *bandoengensis* in all stages. It can be separated from *bicornutus* with certainty only in the male by the uniformly thick proboscis and the absence of prominent lateral and ventral rows of several strong setae in the basal 0.2-0.5 of the labium; from *bandoengensis* in the male genitalia by the presence of 6, 7 submarginal setae in a single row on the inner tergal surface of the basimere (15-17 in double row in *bandoengensis*).

BIONOMICS. *Culex minor* has been encountered in practically all collections from the inland jungle in various parts of Southeast Asia. The adults and immatures are very abundant and have frequently been collected in numbers. The principal breeding sites include bamboos and tree holes. In the Philippines, it has also been found breeding in rock pools, but elsewhere, in Thailand and Malaysia, it was reported to utilize bamboos and tree holes in preference to rock pools (Bram 1967a: Colless 1965). In Malaya, Colless (loc, cit.) noted that the adults appeared to attack man on occasion, otherwise nothing is known about its biology and medical importance.

34. *CULEX (LOPHOCERAOMYIA) BICORNUTUS* (THEOBALD) (Fig. 44)

Lophoceratomyia bicornuta Theobald 1910: 25 (♂*).
Culex (Lophoceratomyia) mammilifer of Barraud 1924: 43; Edwards 1932: 198; Barraud 1934: 374; Stone, Knight and Starcke 1959: 234.
Culex (Lophoceratomyia) plantaginis Barraud (in part), Barraud 1924: 46 (♂*); Barraud 1934: 372 (♂*).
Culex (Lophoceraomyia) minor (Leicester), (in part), Stone, Knight and Starcke 1959: 234 (catalog); Bram 1967a: 97 (♂*, ♀, L*).
Culex (Lophoceraomyia) bicornutus (Theobald), Colless 1965: 291 (♂*, ♀, L*).

FEMALE. As described for *minor* from which it is virtually indistinguishable.

MALE. Exceedingly similar to *minor*, differing from it in the following characters. *Palpus*. Rather longer, usually exceeding proboscis length by 0.5-1.0 of segment 5. *Proboscis*. Relatively thick and moderately to strongly swollen from 0.2-0.5 of the length from base, lateral and ventral surfaces of swollen portion with prominent rows of numerous strong, curved setae. *Antenna*. As figured for *minor* (Fig. 43); F-7 with a stronger and more prominent mesal tuft of dark, flattened spinelike setae which are well separated from 2 other usual tufts on ventral and lateral surfaces.

MALE GENITALIA. Essentially as described and figured for *minor* (Fig. 43) to which it is extremely similar in practically every detail of the basimere, subapical lobe, distimere, phallosome and proctiger.

PUPA. As described and figured for *minor* (Fig. 43) to which it is essentially similar in the detailed chaetotaxy. Cephalothorax and abdomen varying from extensively pale yellowish in specimens from pandanus axils to brownish in the specimens from rock pools or tree holes.

LARVA (Fig. 44). As described and figured for *minor* to which it is essentially similar in the detailed chaetotaxy, differing slightly in the following. *Thorax* and *Abdomen*. Spiculation very variable; those from rock pools and tree holes lightly spiculate, spicules minute and sparse as in *minor;* those from pandanus axils heavily spiculate; spicules dense, hairlike, nearly approaching the conditions noted in *spiculosus;* setae 1 and 6-III-VI relatively stronger and longer; 6-III-VI usually triple, rarely double. *Siphon*. Larger distal pecten teeth with 6, 7 denticles of graded sizes (Fig. 44), 1, 2 basal denticles apparently not differentiated from distal denticles; subventral tufts as in *minor*, sometimes stronger and longer.

TYPE-DATA. Type ♂ (lost), Dawna Hills, nr. Kawkareik, BURMA (LU).

DISTRIBUTION. India, Sri Lanka, Thailand, Vietnam, Peninsular Malaysia, Ryukyus (Japan) and Hainan (China). 1,979 specimens examined: 743♂,

761♀, 475 L; 1,153 with associated immature skins (512 p, 641 lp).

INDIA. *Bombay:* Kawar; 4♂, 2♀.

SRI LANKA. *Central Province*: Imbulpitiya; *Sabaragamuwa Province:* Galle Dist., Kanneliya; *Western Province:* Colombo Dist.,Labugama Reservoir; 36♂, 50♀, 8 L, 9 lp.

THAILAND. *Mae Hong Son:* Ban Pha Chi; Ban Mae Tia; Doi Chang; Ban Mae Ho Nua; Ban Hua Yang; *Lampang:* Ban Pha Daeng; *Chiang Mai:* Doi Sutep; Huey Kaew: Chiang Dao; Huey Pao; Huey Payao; Ban Sap O Nok; Wat Phra That; Ban Doi Sutep; Ban Than Kleap; Ban Mae Sa; Doi Khun Tan; Ban Pha Miang; *Tak:* Doi Sam Sao; *Ubon Ratchathani*: Pibul Muang Saharn; *Nakhon Ratchasima:* Koraj, Pachong; Kabin Buri; Khao Salak Dai; Khao I-Phram; *Nakhon Sawan; Nakhon Nayok:* Huey Tha Krong; Khao Yai; Huey Sai Noi; *Saraburi; Chon Buri:* Bang La Mung; Khao Mai Kaeo; Sriracha, Bang Phra; *Kanchanaburi:* Ban Sai Yok; *Chanthaburi:* Ban Chak Yai; Ban Laem Sing; Khlong Ka Ting; Ban Cham Rung, Ban Sapan Hin; *Trat:* Koh Chang; *Prachuap Khiri Khan:* Tub Sakae; *Chumphon:* Ban Wang Phi; *Ranong:* Kraburi; Khlong Set Takuart; *Krabi:* Ban Mai Kaen Tai; *Phangnga:* Pathum;Nam Tai: Sipsi Hon; *Surat Thani:* Koh Samui; Khao Yai; Khao Plu; Ron Pibul; *Phuket:* Ban Huey Luk; Khao Prathui; Khao Prathin; *Nakhon Si Thammarat:* Phu Wiang; Ban Thuan Lek; Khao Luang; *Phatthalung:* Muang; *Songkhla:* Boripat Water Falls; Tone Nga Chang; *Trang:* Muang; *Narathiwat:* Khau Lau; *Yala:* Yala Bong; 526♂, 540♀, 411 L, 496 p, 437 lp.

VIETNAM. Con Son; 6♂, 1♀, 5 L.

MALAYSIA. *Peninsular Malaysia-Selangor:* Ulu Gombak; K. Kubu-Gap Rd.; Pacific Tin K. Sel.; Banting; *Selangor-Pahang:* The Gap; *Pahang:* Pulau Tioman; Gunong Benom; Fraser's Hill; *Perak:* Kg. Sg. Itek; Cameron Highlands Rd.; Bintang Hijau F. R.; Maxwell's Hill; *Penang Is.;* 117♂, 114♀, 46 L, 16 p, 94 lp.

CHINA. Hainan Is.; 10♂.

JAPAN. *Ryukyus* (Okinawa): Yaeyama; Iriamote; 44♂, 54♀, 5 L, 101 lp.

Additional records from the literature: Botel Tobago near Formosa (Taiwan); lower BURMA; (Colless 1965).

TAXONOMIC DISCUSSION. *Culex bicornutus* is exceedingly similar to *minor* in all stages. It can only be separated from the latter by the male proboscis which differs strikingly in being swollen in the basal 0.2-0.5 and in the presence of prominent rows of several strong curved setae on its lateral and ventral surfaces. These features are remarkably constant in all material examined except in central and northern parts of Thailand where they are variable and occasionally exhibit overlap with the normal condition noted in the typical *minor*. It is quite possible that some of the Thailand specimens which I have identified with *minor* are actually *bicornutus*.

In spite of their close resemblance, *bicornutus* is undoubtedly distinct from *minor* on the basis of their distribution and breeding site. Over most parts of Southeast Asia and adjacent areas, *bicornutus* has been found to be more common and widespread than *minor*. Its occurrence is apparently restricted to the north, extending from India, Sri Lanka eastwards to southern China, northern and central Thailand, Okinawa and perhaps also Taiwan. I have never seen *bicornutus* specimens from Sabah, Indonesia or the Philippines where *minor* is predominant. In Sri Lanka, Hainan and Okinawa, the Ryukyus, however, it appears to completely replace *minor*. In Thailand and Malaysia, both forms are generally or closely overlapping in their occurrence and breeding sites. The differences in the type of the breeding sites between the 2 forms also appear to be rather striking, as noted by Colless (1965); *bicornutus* exhibits a

tendency to breed in rock pools instead of bamboos or tree holes as opposed to *minor* which usually breeds in container habitats in preference to rock pools or other types of ground pools. In addition, *bicornutus* has also been found capable of utilizing a broader spectrum of breeding sites than *minor*. Included among them are pandanus axils, ground pools and artificial containers. On this basis, I am in full agreement with Colless (1965) in treating *bicornutus* as a distinct species instead of relegating it to a form or synonym of *minor* as proposed by Bram (1967a).

In Thailand and Peninsular Malaysia, the larvae of *bicornutus* exhibit considerable variation in the spiculation of the thorax and abdomen, depending on the type of breeding sites; in those from pandanus axils these features are better developed than the ones from rock pools and other breeding habitats. Certain abdominal setae are also variable in the length and in the number of branches as noted in *minor*, indicating that *bicornutus* is probably a composite of several different ecotypes.

BIONOMICS. The majority of the immatures of *bicornutus* from southern Thailand and Peninsular Malaysia were collected in rock pools at stream margins under heavy or partial shade of dense tropical forest and usually contained numerous decayed fallen leaves. Occasionally, they have also been found in tree holes, log holes and bamboo stumps close to the ground, stream pools, wells, puddles, footprints, clay or bamboo pots, coconut shells and pandanus axils. In northern Thailand, it has been reported to utilize rock pools as frequently as tree holes or bamboos. In the Ryukyus, most of the larval collections were from rock pools and only a few from tree holes. The immatures recently collected in Sri Lanka largely came from rock pools. Both pupae and larvae were abundant and have frequently been taken in numbers. The numerous adults have been obtained largely from rearing the pupae and larvae. Nothing is known about the adult biology.

35. *CULEX (LOPHOCERAOMYIA) BANDOENGENSIS* BRUG
(Fig. 45)

Culex (Lophoceratomyia) minor var. *bandoengensis* Brug 1939: 112 (♂).
Culex (Lophoceraomyia) minor (Leicester) of Stone, Knight and Starcke 1959: 234 (catalog).
Culex (Lophoceraomyia) bandoengensis Brug, Colless 1965: 292 (♂*, ♀, L).

FEMALE. Exceedingly similar to *minor* and *bicornutus* from which it can not be distinguished with certainty, differing slightly in having the narrow decumbent scales of the vertex finer, the erect scales more slender and less numerous.

MALE. In general differing from *minor* and *bicornutus* as described for female. *Palpus*. Slender and relatively long, exceeding proboscis by full length of segment 5. *Proboscis*. Uniformly thick, as in *minor*. *Antenna*. Modified tufts of F-5-9 as described for *minor* and *bicornutus*, differing slightly in having the mesal tuft of F-7 more weakly developed, composed of 4, 5 narrow, pale spinelike setae.

MALE GENITALIA (Fig. 45). As figured and described by Colless (1965: 292), differing from *minor* and *bicornutus* as in the following. *Basimere*. Inner tergal surface with a double or triple row of 15-17 very strong sinuous submarginal setae. *Subapical Lobe*. Rod *a* always separated from rods *b*, *c* by a wide gap, but more strongly curved and sometimes distinctly angulate or

elbowed at middle; leaflet g_1 very broad, usually longer than bladelike leaflet g_2; setae *d-f* relatively stronger and more distinct. *Distimere*. Rather short, usually more or less straight with slightly recurved apex; subapical claw short and strongly inflated distally. *Phallosome* and *Proctiger*. Essentially as described for *minor* and *bicornutus*.

PUPA. As figured for *minor* to which it is exceedingly similar in general and detailed chaetotaxy, differing particularly in having seta 8-C usually 3, 4 branched (2-4).

LARVA. As figured for *minor* to which it is exceedingly similar, differing particularly in the following. *Abdomen*. Setae 6-III-VI usually triple (2-3). All comb scales with normal fringe of evenly fine spicules. *Siphon*. Distal teeth of pecten always barbed with 6, 7 denticles of graded sizes.

TYPE-DATA. Holotype ♂* with attached antenna and genitalia mount, Bandoeng (Bandung), *Java*, Dutch East Indies [INDONESIA], reared from larva collected in bamboo stump, elevation 800 meters, 2 Jan. 1934, S. L. Brug (BMNH).

DISTRIBUTION. Peninsular Malaysia and Indonesia. 39 specimens examined: 18♂, 13♀, 7 L; 13 with associated immature skins (2 p, 11 lp).

INDONESIA. *Java:* Bandung (type-locality); Bogor, Botanical Garden; *Ceram;* 10♂, 3♀.

Additional records from the literature: PENINSULAR MALAYSIA-*Selangor*: Fraser's Hill; *Perak:* Maxwell Hill (Colless 1965: 293).

TAXONOMIC DISCUSSION. *Culex bandoengensis* is very closely related to *minor* and *bicornutus*. It can be separated from the latter 2 species particularly by the presence of more numerous submarginal setae in double or triple rows on the basimere of the male genitalia and by the even fringe of the larval comb scales.

Based on the present records, *bandoengensis* appears to be restricted to Peninsular Malaysia and Indonesia. The new record from Ceram is based on a male collected by Brug and de Rook in 1931. This, together with the recent collection of the specimens from Java and Peninsular Malaysia, indicates that it is widespread, probably occurring throughout these areas.

BIONOMICS. As in *minor, bandoengensis* has been frequently found to utilize bamboos and tree holes as the breeding sites. All of the adults from Java were reared from larvae collected in bamboos or tree holes. In Malaya, the immatures were also collected in rock pools in association with numerous specimens of *bicornutus*. On occasion, they were also collected from discarded oil drums and tin cans. All of these collections were made in or near the forest at a high elevation in the mountainous region.

36. *CULEX (LOPHOCERAOMYIA) TUBERIS* BOHART
(Fig. 45)

Culex (Lophoceraomyia) tuberis Bohart 1946: 42 (♂*); Bohart and Ingram 1946: 74 (♂*, ♀, P, L*); Bohart 1953: 185 (♂*, ♀, P, L*).

FEMALE. Specimens not available for this study; the following description is quoted from Bohart (1953: 185): "Agreeing with male in general coloration. Pleuron sometimes greenish, scutal integument medium to dark brown, scales of abdominal tergites all dark. Palpus about one-fifth as long as proboscis, torus with a small but sharp "point" at the upper inner angle corresponding to the pronounced knob of the male, no lower mesepimeral bristle."

MALE. Essentially similar to *minor* and other members of the *minor* complex in antennae, palpal and labial characters, differing in the absence of a lower *mep* bristle, paler coloration and slightly in the following features. *Head*. All narrow decumbent scales of vertex predominantly pale, beige or yellowish white and relatively broad along upper eye margin; erect scales largely pale light brown. *Palpus*. Exceeding proboscis length by a little more than the length of segment 5. *Proboscis*. Uniformly thick, basal 0.2-0.5 not swollen. *Antenna*. As described and figured for *minor;* F-5 with a small inconspicuous tuft of 5 pale narrow, short acute scales or setae, about as long as one flagellomere, followed laterally by 1, 2 longer and broader scales; F-7 with a rather weak mesal tuft of 4, 5 acute setae in addition to the usual tufts of curled setae on ventral and lateral surfaces; F-9 with a strong tuft of 5, 6 dark flattened bristlelike setae.

MALE GENITALIA (Fig. 45). As figured. *Segment IX*. Tergal lobe with 3 weak setae; sternum without any setae or scales towards caudal margin. *Basimere*. Normal; inner tergal surface with 6-8 moderately strong submarginal setae in a row parallel to tergomesal margin, median area laterad of submarginals with a prominent patch of numerous shorter setae. *Subapical Lobe*. Rodlike setae *a-c* largely overlapping from bases to apices; leaflet g_1 broad, long with acuminate apex; seta *h* moderately strong and long; leaflet g_2 and setae *d-f* situated on a hairy elongate stem projecting mesad. Distimere. Normal, slightly curved in middle, distally tapering into a small truncate apex; subapical claw very short and small; ventral minute seta present, rather long; dorsal one absent or not conspicuous. *Phallosome*. As in *minor* and *bicornutus* except for relatively shorter internal process; external process with a distinct spiculose apical lobe and only a few denticles on lower tergal surface.

PUPA. Abdomen: 2.7 mm. Paddle: 0.75 mm. Trumpet: 0.6 mm; index about 15. As figured for *minor* (Fig. 43). Cephalothorax and abdomen whitish or cream-colored. *Trumpet*. Dark, long and rather thin. All setae well developed, as in minor and bicornutus; the following are diagnostic. *Cephalothorax*. Seta 7-C single or double; 8-C double; 9-C usually single (1-2). *Metanotum*. Seta 10-C triple; 11-C double. *Abdomen*. Setae 1-III-VII double or triple; 5-IV-VI single, 5-IV short; 5-V, VI 1.0-1.5 times as long as segment following; 6-III-VI usually double (1-2); 4, 5-VII single; 9-VII double or triple, weakly pectinate; 9-VIII usually 4 branched (3-4), weakly pectinate. *Paddle:* Very broad with characteristic elongate apex which is more or less pointed or acuminate.

LARVA. Head: 0.76 mm. Siphon: 1.5 mm; index 8. Saddle: 0.30 mm; siphon/saddle ratio 5. Head capsule, antenna, siphon and saddle pale, cream-colored or yellowish white. In general as figured for *minor* (Fig. 44) with the following distinctive features. *Head*. Seta 6-C single; 7-C 4, 5 branched. *Thorax*. Spiculation entirely absent; seta 1-M short, 0.25-0.50 of 3-M. *Abdomen*. Spiculation absent; setae 6-I, II with 2 long lateral branches and 1 short median branch; 7-II double; 6-III-VI usually double (1-3); 1-III-VI single or double. Comb scales numerous, 60-70, all with normal fringe of evenly fine spicules. Saddle very weakly spiculate on posterior caudal margin; seta 2-X double; anal gills fusiform, as long as saddle. *Siphon*. Relatively thick and straight; pecten teeth 11-13, larger distal teeth barbed with 2, 3 distinct basal denticles and 6, 7 very fine distal denticles; subventral tufts 4 pairs, usually triple (2-3) each, first proximal pairs 1.5 times as long as siphonal width at point of attachment, the remaining pairs gradually shorter; median caudal filament of spiracular apparatus absent or not developed.

TYPE-DATA. Holotype ♂* with slide of antenna and genitalia, Chizuka,

Okinawa, Ryukyu Retto, [JAPAN], reared from larva collected in a rock hole along a stream, Sept. 1945, R. Bohart and R. Ingram (USNM, No. 57760).

DISTRIBUTION. Okinawa, the Ryukyus and Chiang Mai, Thailand. 8 specimens examined: 5♂, 3 L, 2 pupal skins.

THAILAND. *Chiang Mai:* Doi Sutep; 2♂ (M481-8; M559).

JAPAN. *Ryukyus-Okinawa:* Chizuka; E. Taira; 3♂ (including holotype); 3 L, 2 p.

TAXONOMIC DISCUSSION. The above description of the male of *tuberis* has been based on the holotype and a few paratypes originally designated by Bohart (1946: 42-3) and those of the pupa and larva have been based on the specimens associated with the males subsequently described by the same author (Bohart 1953: 185-6). In addition, I have also discovered 2 males of *tuberis* among the specimens of *minor* in the collection of E. B. and D. C. Thurman from Chiang Mai, Thailand. These males differ slightly from the Okinawan specimens in having finer and longer scales in the modified tuft of antennal flagellomere 5 but are essentially similar to the latter in every detail of the male genitalia.

Except for the specific diagnostic features as noted above and as indicated in the keys, the male, male genitalia, pupa and larva of *tuberis* are extremely similar to those of *minor* and *bicornutus* with which it evidently falls into the same complex. This, together with the presently known distribution, seems to suggest that *tuberis* probably originated in Southeast Asia as a derivative of *minor* and subsequently spread into the southern Ryukyus.

BIONOMICS. In Okinawa, the larvae and pupae of *tuberis* were collected by Bohart (1953) in deep rock holes at the side of a cliff in association with specimens of *Uranotaenia stonei* Bohart and Ingram. All adults apparently came from rearing larvae collected in the field. The 2 males from Thailand were labelled as coming from sweeping with net.

37. *CULEX (LOPHOCERAOMYIA) KUHNSI* KING AND HOOGSTRAAL (Fig. 46)

Culex (Lophoceraomyia) kuhnsi King and Hoogstraal 1955: 1 (♂*, ♀, L*); Sirivanakarn 1968: 75 (♂*, ♀, P*, L*).

Culex (Lophoceraomyia) uniformis of Delfinado 1966: 114 (P*; L*; misidentification).

Culex (Lophoceraomyia) uniformis ssp. *mercedesae* Baisas 1974: 65 (♂*, ♀, P, L*). NEW SYNONYMY.

FEMALE. Wing: 3.0 mm. Forefemur: 1.7 mm. Proboscis: 1.8 mm. Medium-sized, blackish species, exceedingly similar to *minor* and most members of the *minor* complex, differing slightly in the following. *Head*. Narrow decumbent scales of vertex entirely or predominantly pale whitish, scales on upper eye margin relatively broad, clavate, forming a distinct ocular line; erect scales entirely dark; lateral white patch of broad scales distinct. *Cibarial Armature*. As described for *minor*. *Thorax*. Lower *mep* bristle present, usually 1, sometimes 2. *Legs*. Entirely dark or black scaled except for the anterior surface of hindfemur which is broadly pale whitish in basal 0.25, gradually narrowed in apical portion.

MALE. As figured and described by King and Hoogstraal (1955: 1-4) and Sirivanakarn (1968: 96-9); essentially similar to *minor* in antennal, palpal and labial characters, differing slightly in the following. *Antenna*. F-5 with 6-9

short, narrow, acute scales; modified tufts of F-6, 7 variable from weakly to strongly developed; F-7 with a mesal row or tuft of weak acute setae in addition to other 2 tufts of curled setae on ventral and lateral surfaces; F-8 with a weakly hooked tuft of 6, 7 fused setae; F-9 with or without 2, 3 weak bristlelike setae.

MALE GENITALIA (Fig. 46). Essentially conforming to the *minor* complex in the phallosome. *Segment IX*. Tergal lobe with 2, 3 weak and short setae; sternum with a transverse row of 6, 7 strong setae towards caudal margin. *Basimere*. Normal; inner tergal surface slightly convex, with 3, 4 relatively weak submarginal setae in a row parallel to tergomesal margin, most basal submarginal setae usually weaker than other 2, 3 submarginals; short setae laterad of submarginal moderately strong and dense. *Subapical Lobe*. Rodlike setae *a*-*c* subequal, largely overlapping from bases to apices; leaflet g_1 broad, striated; seta *h* very strong, long and apically hooked. *Distimere*. Normal. *Phallosome*. Internal process simple, stout and long, not projecting beyond apex of external process; external process broad, with constricted apical spiculose lobe sternad, tergal surface with several strong denticles in 2, 3 irregular rows, inner surface with variable number of toothlike marks. *Proctiger*. Apical crown large; paraproct and cercal sclerite well sclerotized and pigmented; cercal setae 3.

PUPA. Abdomen: 2.7 mm. Paddle: 0.72 mm. Trumpet: 0.78 mm; index 10-12. In general as figured for *minor* (Fig. 43); cephalothorax and abdomen brownish or strongly yellowish. *Trumpet*. Slender, dark brown; apical portion of meatus distad of annulation lightly spiculate. All setae developed, the following are diagnostic. *Cephalothorax*. Seta 5-C stronger and longer than 7-C, usually double (2-3); 8, 9-C usually triple (3-4). *Metanotum*. Seta 10-C 3, 4 branched; 11-C always single. *Abdomen*. Setae 3-I-III single or double; 5-IV, V single or double, subequal, 2 times as long as segment following; 5-VI shorter, always single; 6-III-VI usually single (1-2); 9-VII 4-branched, strongly pectinate; 9-VIII strong, usually with 10 strongly pectinate branches. *Paddle*. Broad and entirely pale whitish, contrasting sharply with color of abdomen; midrib weak, lightly pigmented.

LARVA (Fig. 46). Head: 0.74 mm. Siphon: 1.2 mm; index 9. Saddle: 0.26 mm; siphon/saddle ratio 5. Superficially very similar to *uniformis* and *spiculosus* in having thorax and abdomen heavily spiculated, differing from the latter 2 species and from all other members of the *Mammilifer* Subgroup in the following characters. *Head*. Strongly yellowish to brownish; ventral surface at level of ocular bulge with a broad band of numerous spicules; seta 1-C dark, basally swollen, distally simple or forked into 2, 3 apical spines, or sometimes with 1 lateral spine on each side of large median spine; 5-C 2-4 branched; 6-C 1-3 branched; 12, 13-C remarkably flattened and very dark; 12-C 3, 4 branched; 13-C 4-6 branched. Antenna slender, relatively short and largely pale yellowish; spicules numerous, rather fine and sharp. *Thorax*. Spicules densely packed, hairlike, 4-6 branched; seta 8-P minute, similar to spicules, usually single (1-2); 14-P usually single, sometimes double. *Abdomen*. Spiculation as in thorax; setae 6-I, II and 7-I dark, stout; 6-I, II usually triple, sometimes 4-branched; 7-I double; 6-III-VI usually triple (3-4), median branch weaker and shorter than lateral branches; 1-III-VI strong, 0.5 of length of 6-III-VI, double or triple. Comb scales about 40, scales on anterior rows small, short, with normal fringes of spicules, those on posterior row enlarged, terminating into a stout apical spine. Saddle usually dark brown and strongly spiculate; posterior caudal margin densely packed with numerous heavy spines; seta 2-X 3, 4 branched, all branches subequally long; anal gills

slender, 2 times as long as saddle length. *Siphon.* Slender, moderately long, yellowish or concolorous with head capsule; pecten teeth 15-20, denticulation strongly differentiated, basal teeth barbed with 2-4 strong denticles, median teeth with 1,2 denticles, 2-4 distal teeth usually simple; subventral tufts strong, 4 pairs, 4, 5 branched each, first 1, 2 proximal tufts longest, 3, 4 times as long as siphonal width at point of attachment, next 2 distal tufts gradually reduced in length; median caudal filament of spiracular apparatus absent or not developed.

TYPE-DATA. (1) *Culex (L.) kuhnsi* King and Hoogstraal; Holotype ♂* (766C) with slide of antenna and genitalia, Doromena, Hollandia (Kota Baru), *Netherlands New Guinea* [West Irian, INDONESIA] reared from larva from a shaded tree hole in open coastal hillside woods, 24 Feb. 1945, H. Hoogstraal and W. H. Christ (USNM); (2) *Culex (L.) uniformis* ssp. *mercedesae* Baisas, Type not specified; Mt. Makiling, *Luzon,* PHILIPPINES (LU).

DISTRIBUTION. Sabah, Malaysia; Philippines; Ceram, Indonesia and New Guinea (including West Irian, Indonesia and Papua New Guinea). 93 specimens examined: 44♂, 22♀, 27 L; 41 with associated immature skins (7 p, 34 lp).

MALAYSIA. *Sabah:* Tawau; Keningau; 6♂.

PHILIPPINES. *Luzon:* Bataan Province, Paysawan; Mt. Makiling; Subic Bay (Naval Base); Calaca; Baguio; Dalton, N. Vizcaya; *Mindoro:* San Jose; *Negros:* Fabrica Occidental; *Leyte:* Balinsasa Yao; Lago Lago Bay; *Mindanao:* Kolambugan; Davao, Cotabato; Wenes; Mt. Apo; *Jolo:* Indanan; Mampallan, Tali Pao; 38♂, 22♀, 26 L, 7 p, 34 lp.

INDONESIA. *West Irian:* Kota Baru (Hollandia), Doramena; *Ceram;* 4♂, 1 L, 2 lp.

Additional records from the literature. PAPUA NEW GUINEA: Sepik District, Vanimo (Sirivanakarn 1968: 96-100).

TAXONOMIC DISCUSSION. *Culex kuhnsi* is very widespread, with a range extending from New Guinea to the Philippines and Sabah. Because of the densely spiculose larva, *kuhnsi* has been repeatedly confused in the past with *uniformis*. As discussed under the latter, the Philippine records of *uniformis* by Delfinado (1966: 114) and Baisas (1974: 121, as subsp. *mercedesae*) are in error, due to misidentifications. It is also possible that *mindanaoensis* Baisas (1938) is in fact *kuhnsi*. However, as the type of the former no longer exists the point cannot be settled. In comparing the Philippine specimens and others currently available with the type and topotypic material from New Guinea, I found them extremely similar in all stages and on this basis I am convinced that they all belong to *kuhnsi*.

All stages of *kuhnsi* are very variable, but there is no indication of local differentiation among the material examined. The males from the Philippines and Sabah differ slightly from those in New Guinea, particularly in the presence or absence of weaker and fewer bristlelike setae in the modified tuft of antennal flagellomere 9. The larva exhibits considerable individual variation in the branching of setae 1, 5, 6-C and 6-I, II. The Philippine larvae differ slightly from those in New Guinea in having the posterior comb scales terminating into a stronger and longer median apical spine, otherwise both forms agree perfectly in general and in the detailed chaetotaxy. The pupae are also very variable in pigmentation, but all apparently conform to the diagnostic chaetotaxy as indicated in the above diagnosis.

BIONOMICS. The immatures of *kuhnsi* have been frequently collected from tree holes and occasionally from bamboos at a broad range of elevation. In the Philippines, they were also found in rock pools, discarded tin cans and foot prints along stream margins and forest trails. In Sabah, only adults were

collected, presumably by sweeping with a net among foliage in the forest.

38. *CULEX (LOPHOCERAOMYIA) CRASSICOMUS* COLLESS
(Fig. 47)

Culex (Lophoceraomyia) crassicomus Colless 1965: 296 (♂*).

FEMALE. Unknown.

MALE (Fig. 47). Based on the holotype. Essentially similar to other members of the *minor* complex. *Head*. Narrow decumbent scales of vertex largely pale beige, very narrow, linear and fine in center, slightly broader on ocular line; erect scales slender and entirely blackish. *Palpus*. Slightly longer than proboscis by a little less than the length of segment 5. *Proboscis*. Uniformly thick. *Antenna*. As described and figured by Colless (1965: 296); spiculose prominence on pedicel more or less blunt, not clearly projecting outwards; modified tufts of setae and scales present on F-5 to F-9; F-5 with a small tuft of 2-4 dark, narrow, acute, spinelike scales about as long as the next 2 flagellomeres, preceded to dorsally by 1, 2 long normal setae; F-6, 7 with usual strong, dark, crumpled tufts of curled setae as in other species; mesal tuft or row of short, narrow setae of F-7 poorly developed or indistinct; F-8 with a relatively thick dark tuft of 7, 8 fused setae in form of a typical J-hook rather than sigmoid; modified tuft of F-9 with 4, 5 dark, flattened bristle-like setae and 3, 4 other finer setae; middle portion of F-9 to F-11 with several scattered hairlike setae as long as one flagellomere distad of normal whorls of long setae.

MALE GENITALIA (Fig. 47). As described and figured by Colless (1965: 296). *Segment IX*. Tergal lobe with 2 weak setae; sternum with an irregular transverse row of 5, 6 strong setae on caudal margin. *Basimere*. Normal; inner tergal surface with 4, 5 submarginal setae in a linear row parallel to tergomesal margin; marginal setae weak and rather sparse; short setae laterad of submarginals on outer surface weak and relatively few in number. *Subapical Lobe*. Rodlike setae *a-c* largely overlapping; seta *a* thick, distinctly broadened and strongly curved upwards in apical portion; leaflet g_1 narrow, acuminate; seta *h* moderately long; setae *d-f* consist of 2, 3 narrow bladelike setae; leaflet g_2 long, rodlike and strongly bent in middle. *Distimere*. Slender, normal. *Phallosome*. Internal process strong, but its apex not projecting beyond apex of external process; external process with distinct spiculose lobe sternad, its upper tergal surface with only few denticles or tubercles.

PUPA and LARVA. Unknown.

TYPE-DATA. Holotype ♂* with slides of antenna (CH 152) and genitalia (CT 571), Ulu Gombak, *Selangor*, Malaya [MALAYSIA], March 1956, D. H. Colless (ANIC).

DISTRIBUTION. Known only from Selangor and Sabah, Malaysia. 3♂ examined.

MALAYSIA. *Peninsular Malaysia - Selangor:* Ulu Gombak (type-locality); 1♂ (holotype); Malaysia - Sabah: Tawau; 2♂.

TAXONOMIC DISCUSSION. In addition to the holotype, I observed 2 other males of *crassicomus* in the BMNH. They were collected by D. H. Colless at Tawau, Sabah, during February 1960. One of these agrees perfectly with the holotype but the other differs in having fewer and thicker curled setae on the flagellomeres 6, 7 and in the complete absence of scattered setae in the middle of antennal flagellomeres 9-11. In the male genitalia, the phallosome of the

second male also differs from the typical specimen in having more numerous denticles on the upper tergal surface of the external process. It is possible that this specimen probably represents a distinct species, but pending further study of additional material, it is now tentatively identified with *crassicomus*.

The male of *crassicomus* can be separated from other members of the *minor* complex in the antenna by the form of the modified tufts of flagellomeres 5 and 8 and the presence of several scattered setae distad to the normal whorls of flagellomeres 9-11; in the male genitalia by the presence of 4, 5 submarginal setae on the basimere, the characteristic development of rodlike seta *a* of the subapical lobe and by the presence of only a few denticles or tubercles on the external process of the phallosome. The male genitalia of *crassicomus* are apparently more similar to *bengalensis* and *peytoni* than to any other species in the *Mammilifer* Subgroup, suggesting that they are closely related.

BIONOMICS. The males of *crassicomus* were collected by sweeping among foliage (Colless 1965: 296). The breeding site and adult biology are unknown.

39. *CULEX (LOPHOCERAOMYIA) INCOMPTUS* BRAM AND RATTANARITHIKUL (Fig. 48)

Culex (Lophoceraomyia) incomptus Bram and Rattanarithikul 1967: 16 (♂*); Bram 1967a: 81 (♂*).

FEMALE. Unknown.

MALE (Fig. 48). Exceedingly similar to other members of the *minor* complex, differing slightly in the following. *Antenna*. Flagellar whorl weakly plumose or with relatively fewer normal long setae; F-5 with a small, distinct tuft of 5, 6 dark, narrow, acute scales, as long as the next 2 flagellomeres, preceded dorsally by 1 normal long seta, 4, 5 dorsal scales subequal, 1, 2 ventralmost scales slightly longer; F-6 with a strong crumpled tuft of several curled setae; F-7 with a lateral combed-tuft of several curled setae as in most forms, a slender ventral tuft of weak fused setae and a weak mesal tuft (or row) of fine acute setae; F-8 with a slender, smooth J-hooked tuft of 7, 8 fused setae, some of which are distinctly swollen at about middle before tapering into fine points; F-9 with 2-4 dark, slender bristlelike setae; F-8-11 with 2, 3 very short setae at middle of flagellomere distad of bases of normal whorls.

MALE GENITALIA (Fig. 48). *Segment IX*. Tergal lobe with 3-5 moderately strong setae; sternum with 1 strong seta towards caudal margin at middle. *Basimere*. Normal; submarginal setae moderately strong, 6, 7 in number, in a linear row accompanied by a number of shorter setae along tergomesal margin. *Subapical Lobe*. Rodlike setae *a-c* subequal and largely overlapping; leaflet g_1 well developed; seta *h* moderately strong; 1, 2 weaker setae present laterad and mesad of seta *h;* leaflet g_2 strong, rodlike; setae *d-f* weak, hairlike. *Distimere*. Normal; subapical dorsal surface with a weak crest of very fine spicules, somewhat similar to *mammilifer*. *Phallosome*. Well sclerotized; internal process strong, not projecting beyond apex of external process, the latter with several strong denticles on upper tergal surface and a distinct spiculose apical lobe sternad; inner surface with a number of distinct toothlike marks proximally. *Proctiger*. Essentially similar to other members of the *minor* complex; cercal setae 2, 3.

PUPA and LARVA. Unknown.

TYPE-DATA. Holotype ♂* (M405-4) with slides of antenna and genitalia, Doi Sutep, *Chiang Mai*, THAILAND, 7 Jan. 1953, D. C. and E. B. Thurman (USNM; No. 69186).

DISTRIBUTION. Known only from Chiang Mai, Thailand. 4♂ examined.

THAILAND. *Chiang Mai:* Doi Sutep (type-locality); Doi Tad Fah; 4♂ (including holotype).

TAXONOMIC DISCUSSION. *Culex incomptus* can be readily separated from other members of the *minor* complex in the male antenna by the presence of 2, 3 short setae distad of normal whorls of flagellomeres 8-11 and by the differences in the modified tufts of flagellomeres 5-8. The male genitalia of *incomptus* resemble *mammilifer* in the presence of a fine crest of spicules on the dorsal subapical surface of the distimere but its phallosome is similar to *minor* and other members of the *minor* complex. Based on the latter feature, *incomptus* is here assigned to the *minor* complex.

BIONOMICS. The males of *incomptus*, including the holotype, were caught while resting among vegetation in a forest at a very high elevation in the mountain region. The associated larvae, which were lost, were collected from a tree hole (Bram and Rattanarithikul 1967: 17).

40. *CULEX (LOPHOCERAOMYIA) BENGALENSIS* BARRAUD
(Fig. 49)

Culex (Lophoceratomyia) minor var. *bengalensis* Barraud 1934: 371 (♂).
Culex (Lophoceraomyia) bengalensis Barraud, Colless 1965: 293 (♂*, ♀, L); Bram 1967a: 83 (♂*, ♀, L*).

FEMALE. Wing: 3.0 mm. Forefemur: 1.3 mm. Proboscis: 1.5 mm. Differing from other members of the *minor* complex particularly in the absence of a lower *mep* bristle, relatively slender size and in having decumbent scales of vertex broad clavate along upper eye margin.

MALE (Fig. 49). Differing from other members of the *minor* complex as described for female and as in the following. *Palpus*. Exceeding proboscis length by at least full length of segment 5; segments 4 and 5 apparently with more numerous strong bristles on lateral and mesal surfaces. *Proboscis*. Uniformly slender and thin. *Antenna*. Flagellar whorls densely plumose; distinct modified tufts of setae developed only on F-6-9; F-5 usually without any modified setae or scales, sometimes with 2, 3 inconspicuous short fine hairlike setae among the dense row of normal long setae; F-6, 7 with crumpled tufts of curled setae as in *mammilifer* or *minor;* F-8 with a slender typical sigmoid hooked tuft of 6 fused setae; F-9 with 3, 4 weak bristlelike setae.

MALE GENITALIA (Fig. 49). Essentially conforming to the *minor* complex. *Segment IX*. Sternum usually without any setae, sometimes with a transverse row of 4 strong setae towards caudal margin. *Basimere*. Very slender, inner tergal surface with a row of 4, 5 moderately strong submarginal setae parallel to tergomesal margin; marginal setae weak and sparse; short setae laterad of submarginals weak, short and rather few in number. *Subapical Lobe*. Rodlike setae *a-c* slender, largely overlapping from base to apices; rod *a* distally expanded and curved upwards as in *crassicomus;* leaflet g_1 club-shaped; seta *h* moderately strong; leaflet g_2 rodlike, straight; setae *d-f* slender, simple, bladelike. *Distimere*. Subapical dorsal surface without crest of fine spicules. *Phallosome*. Internal process strong and long but not

projecting beyond apex of external process, latter with a constricted apical spiculose lobe sternad and 6-10 strong denticles on its upper tergal surface, inner surface with or without toothlike marks. *Proctiger*. As in *minor*.

PUPA (Fig. 49). Abdomen: 2.3 mm. Paddle: 0.63 mm. Trumpet: 0.62 mm; index 12-15. Cephalothorax and abdomen pale creamy or yellowish white. *Trumpet*. Dark, slender, long, uniformly cylindrical; pinna with distinct slit extending into meatus. Chaetotaxy as figured. *Cephalothorax*. Seta 1-C usually 4, 5 branched; 5-C subequal to 7-C, usually 5 branched (4-7); 8-C usually double (2-3); 9-C double or triple. *Metanotum*. Seta 10-C usually double (1-3); 11-C double. *Abdomen*. Setae 5-IV-VI as long as or slightly longer than segment following; 5-IV 4-6 branched; 5-V, VI double; 6-III-VI usually 4 branched (3-5); 9-VII usually triple (2-4); 9-VIII usually 5, 6 branched (4-7). *Paddle*. Broad, pale whitish or almost transparent; midrib weak, lightly pigmented.

LARVA. Head: 0.65 mm. Siphon: 1.7 mm; index 9. Saddle: 0.27 mm; siphon/saddle ratio 6. As figured for *mammilifer* (Fig. 34), with the following diagnostic features. *Head*. Pale creamy or yellowish white; setae 5, 6-C double. Antenna largely pale, same color as head capsule; spicules numerous and strong. *Thorax*. Spiculation absent; seta 7-P usually double (2-3); 8-P double, subequal to 7-P; 14-P double. *Abdomen*. Setae 6-I, II triple; 6-III-VI usually triple (3-4); 1-III-VI usually triple (2-4). Comb scales 40-50, all of which are rather minute, subequal, with normal or rounded apical fringe of evenly fine spicules. Saddle very lightly spiculate on posterior caudal margin; seta 2-X double. *Siphon*. Slender, same color as head; pecten teeth 12, 13 all apparently barbed with 7, 8 graded denticles, basal denticles not differentiated from distal ones; subventral tufts 3 pairs, widely spaced, double or triple each, most proximal pair twice as long as siphonal width at point of attachment, the remaining distal pairs gradually shorter; median caudal filament of spiracular apparatus well developed.

TYPE-DATA. Lectotype ♂* (only antenna (1451) and genitalia (1452) slides, the remainder of the specimen is completely lost), Nongpoh, Shillong, *Assam:* INDIA, June 1922. P. J. Barraud (BMNH; selection of Colless 1965: 293).

DISTRIBUTION. India, Thailand, Malaysia and Indonesia; also reported from Hainan, China. Not known elsewhere. 71 specimens examined: 41♂, 22♀, 8 L; 28 with associated immature skins (15 p, 13 lp).

INDIA. *Assam:* Shillong, Nongpoh (type-locality); 1♂ (lectotype).

THAILAND. *Nan; Ranong:* Muang; Kraburi; *Phangnga:* Tang Mai; *Phuket:* Khao Prathin; *Krabi:* Ban Mai Kaen Tai; Khao Chaung; *Narathiwat:* Khau Lau; 10♂, 3♀, 4 L, 8 p, 1 lp.

MALAYSIA. *Peninsular Malaysia - Pahang:* Gunong Benom; 26♂, 19♀, 7 p, 12 lp. *Malaysia - Sabah:* Tawau; Mt. Kinabalu; 2♂, 4 L.

INDONESIA. *Kalimantan:* Tarakan; 2♂.

Additional records from the literature: CHINA. Hainan (Chu 1957: 145-63 as var. of *minor*); MALAYSIA. Selangor: Ulu Gombak; Trengganu: Gunong Tebu (Colless 1965: 293-4); INDIA. North Bengal: Sukna and Marianbarrie Tea Estate (Barraud 1934: 372, as var. of *minor*).

TAXONOMIC DISCUSSION. Culex *bengalensis* is differentiated from the preceding species in the *minor* complex by the combination of the male antennal characters and genitalia as described above and as indicated in the key. The male genitalia are exceedingly similar to *crassicomus* from which it can be separated by the presence of more numerous denticles on the upper tergal surface of the external process of the phallosome. Both the pupa and larva of *bengalensis* exhibit considerable overlap and extreme similarity to *mam-*

milifer in general and in the detailed chaetotaxy. It can be separated from the latter in the larva by the double seta 14-P and the stronger and longer subventral tufts of siphon. No clear-cut characters have been found to separate the pupa of *bengalensis* from that of *mammilifer* except for the usual number of branches of a few setae as given in the key.

All the above records of *bengalensis*, including those from the literature are valid except from Hainan, China by Chu (1957; 1958), which is doubtful and requires confirmation.

BIONOMICS. The immatures of *bengalensis* came largely from collections made in general ground pools (including stream pools), foot prints, puddles and wheel tracks at the edges of small streams or rivers in mountainous areas at an elevation ranging from 500-1, 500 m. On a few occasions, they were also collected from rock pools and holes in fallen logs lying on the ground. The larvae and pupae from stream pools have frequently been found in association with specimens of *mammilifer*. All adults apparently came from rearing the pupae and larvae.

peytoni complex

41. *CULEX (LOPHOCERAOMYIA) PEYTONI* BRAM AND RATTANARITHIKUL
(Figs. 50, 51)

Culex (Lophoceraomyia) peytoni Bram and Rattanarithikul 1967: 7 (♂*, ♀, L*); Bram 1967a: 100 (♂*, ♀, L*).

FEMALE. Wing: 3.2 mm. Forefemur: 1.6 mm. Proboscis: 1.9 mm. Medium-sized, blackish species, exceeding similar to the members of *minor* complex from which it can not be distinguished with certainty. *Head*. Narrow decumbent scales of vertex very fine, pale, whitish along upper eye border, forming a narrow ocular line, scales in center predominantly blackish or sometimes pale yellowish; all erect scales blackish; lateral white patch minute, rather indistinct. *Cibarial Armature*. Cibarial bar with about 40 elongate teeth in a concave row. *Thorax*. Mesonotal scales blackish and rather coarse; 1 lower *mep* bristle. *Legs*, *Wing* and *Abdomen*. Essentially similar to *minor* and its closely related species.

MALE (Fig. 50). Extremely similar to *bengalensis*, differing particularly in the following details. *Antenna*. Modified tuft of F-5 absent or poorly developed, with or without 1, 2 short, fine hairlike setae as long as the combined length of the next 2 flagellomeres among several normal long setae, sometimes with only 1 long, very narrow acute scale; modified tuft of F-6, 7 poorly or well developed; F-7 with a distinct mesal row of 6-8 short, straight or distally curved setae in addition to crumpled tufts of curled setae on lateral and ventral surfaces; F-8 with a slender or thick tuft of 4-6 fused setae which are rather straight or slightly curved subapically, but not strongly hooked or sigmoid as in most forms; F-9 with 2-4 weak or strong bristlelike setae; setae distad or normal whorls of flagellomeres 9-11 practically absent.

MALE GENITALIA (Fig. 50). Exceedingly similar to *bengalensis* and *crassicomus;* differing in the following features. *Segment IX*. Sternum always with a transverse row of 7, 8 strong setae towards caudal margin. *Basimere*. Inner tergal surface usually with 4 relatively weaker submarginal setae in a row parallel to tergomesal margin, sometimes 5; marginal setae and

setae laterad of the submarginals strongly reduced and very sparse. *Subapical Lobe*. Setae *d-f* well developed and more conspicuous, 3, 4 in number; leaflet g_1 broad, striated and acuminate. *Phallosome*. Poorly sclerotized; internal process rather weak and short; external process very broad, upper tergal surface irregular, with a few to several weak denticles; apical tergal portion strongly expanded or produced into a blunt point, projecting tergad in lateral aspect; apical lobe (or knob) reduced and weakly spiculate.

PUPA (Fig. 50). Abdomen: 2.4 mm. Paddle: 0.61 mm. Trumpet: 0.60 mm; index 8-10. Exceedingly similar to *ganapathi*, differing from it in the following combination of characters. Cephalothorax and abdomen usually yellowish to dark brownish, sometimes lighter. *Trumpet*. Dark brown and relatively thick; apical portion of meatus distad of proximal annulation moderately spiculate; pinna without slit extended to meatus. *Cephalothorax*. Seta 1-C double or triple; 5-C usually double, dark, as long as 7-C; 8, 9-C usually double (1-3). *Metanotum*. Seta 10-C double; 11-C always single. *Abdomen*. Setae 3-I-III single; 3-III long and dark; 5-IV-VI usually single (1-2) and remarkably long; 5-IV, V 1.5-2.0 or more of segment following; 5-VI as long as or slightly longer than segment following; 6-III-VI weak, subequally long, usually double (2-3); 9-VII 2-4 branched; 9-VIII 6-9 branched. *Paddle*. Very broad and pale.

LARVA (Fig. 51). Head: 0.78 mm. Siphon: 1.6 mm; index 8, 9. Saddle: 0.30 mm; siphon/saddle ratio 5, 6. Essentially conforming to the *Mammilifer* Subgroup with general and detailed chaetotaxy resembling *ganapathi*, differing from it in the following combination of characters. *Head*. Integument yellowish white with or without dark brownish areas; seta 1-C slender, simple, dark, spiniform; 5, 6-C always double; 7-C 8, 9 branched. Antenna usually pale yellowish, sometimes darkened; spicules moderately strong. *Thorax*. Lightly spiculate; spicules minute, dotlike and moderately dense; seta 7-P double; 8-P single, subequal to 7-P; 14-P always double. *Abdomen*. Spiculation absent; setae 6-I, II and 7-I usually stout and dark, sometimes pale; 6-I, II triple; 7-I double; 6-III-VI subequal, usually double, sometimes triple; 1-III-VI variable in length; 1-III usually triple (2-3); 1-IV-VI usually double (2-3). Comb scales 35-40, all subequal in size and with normal apical fringe of evenly fine spicules. Saddle lightly to moderately infuscated; posterior caudal margin lightly spiculate; seta 2-X usually double (2-3); anal gills 1-3 times as long as saddle length. *Siphon*. Usually yellowish, sometimes darker, but not brownish; pecten teeth 11-14; large distal teeth with 1, 2 strong, basal denticles and 6, 7 fine, graded, distal denticles; subventral tufts moderately strong, 4 pairs; first 3 proximal pairs double or triple, 1.5-2.0 times as long as siphonal width at point of attachment; most distal pair shortest, 3-5 branched; median caudal filament of spiracular apparatus not developed.

TYPE-DATA. Holotype ♂* (PU8-45) with associated larval and pupal skins and slide of antenna and genitalia, *Patthalung*, THAILAND, tree hole, 12 feet (approximately 4 m) above the ground, 15 Oct 1964, K. Mongkolpanya (USNM; No. 69182).

DISTRIBUTION. Thailand, Vietnam, Malaysia, Indonesia, Andaman Islands (India). 124 specimens examined: 57♂, 32♀, 35 L; 69 with associated immature skins (27 p, 42 lp).

THAILAND. *Mae Hong Son:* Doi Chang; *Chiang Mai:* Doi Sutep; *Nan:* Ban Wang Mo; *Khon Kaen:* Phu Wiang; *Chanthaburi:* Khao Hin Phaeng; *Chumpon:* Ban Wang Phi; *Ranong:* Koh Chang; Ban Bang Hin; Khlong Bang Man; *Phangnga:* Tak Khet; Tang Mai; Thap Wen; *Nakhon Si Thammarat:* Ban Thuan Lek; Ban Sai Kae; *Trang:* Muang, National Park; Ban Kan Tang Tai; *Phatthalung:* Muang

(type-locality); *Narathiwat:* Waeng; 25♂, 14♀, 35 L, 23 p, 17 lp.

VIETNAM. Pleiku, Plei Djereng; Kontum; 7♂, 2♀.

MALAYSIA. *Peninsular Malaysia - Pahang:* Mela K. Lipis; The Gap; *Perlis:* Kg. Wang Tangga; Padang Besar: Kg. Wang Kelian; *Kedah:* Sintok, F. R.; 20♂, 15♀, 4 p, 23 lp.

INDONESIA. *Java:* Ciran Jang, Ciloto; *Sumatra:* Bengkoelen; 4♂, 1♀, 2 lp.

INDIA. Andaman Islands; 1♂ (slide of antenna and genitalia only).

TAXONOMIC DISCUSSION. *Culex peytoni* and *eukrines* are very closely related and apparently fall into a complex which combines the features of the *minor* complex in the male antenna and genitalia and of the *ganapathi* complex in the pupa and larva. Except for the additional details described above, the males and larvae of *peytoni* essentially agree with the original descriptions and figures by Bram and Rattanarithikul (1967: 7-9). All stages of *peytoni* are very variable. Caution should be taken in separating the males of *peytoni* from those of *bengalensis* and *crassicomus*, and the larvae and pupae from those of *ganapathi*. The most diagnostic features of the male genitalia of *peytoni* are the well developed setae *d-f* of the subapical lobe; the very broad and poorly sclerotized external process of the phallosome and the weakly spiculate apical lobe of the external process. The pupa resembles *ganapathi* in the detailed chaetotaxy but differs from it in having thicker trumpet, shorter and weaker setae 5-C and 6-III-VI. The larva differs from *ganapathi* particularly in the simple and more slender seta 1-C and in having stronger basal denticles of the pecten teeth.

In addition to the records from Thailand, *peytoni* is also known from other neighboring countries, as noted above, indicating that it is one of the very widespread species in the *Mammilifer* Subgroup.

BIONOMICS. The common breeding sites of *peytoni* are either tree holes or bamboos in tropical rain forests. On a few occasions, the larvae have also been found in fallen coconut shells. Bram and Rattanarithikul (1967: 9) noted that it was once collected in a rock hole. These breeding sites were located at a broad range of elevation.

42. *CULEX (LOPHOCERAOMYIA) EUKRINES* BRAM AND RATTANARITHIKUL
(Fig. 52)

Culex (Lophoceraomyia) eukrines Bram and Rattanarithikul 1967: 11 (♂*, ♀, L*); Bram 1967a: 85 (♂*, ♀, L*).

FEMALE. As described for *peytoni* to which it is almost identical, differing slightly in having narrow decumbent scales of vertex largely pale yellow, forming a broader ocular line on anterior margin and erect scales varying from partially yellowish brown or golden to entirely black. *Cibarial Armature.* Similar to *peytoni* from which it is indistinguishable.

MALE (Fig. 52). Exceedingly similar to *peytoni*, differing chiefly in the following. *Antenna.* Flagellar whorls more densely plumose; F-5 with or without 1, 2 fine hairlike setae among several normal long setae; F-6, 7 with strongly reduced or poorly developed tufts of curled setae; mesal setae of F-7 finer and longer, projecting beyond F-8; modified tuft of F-8 more slender, smoothly curved or gently hooked subapically; F-9 with 4, 5 weak bristlelike setae.

MALE GENITALIA (Fig. 52). As figured, almost identical to *peytoni*, differing slightly in the following. *Basimere*. Usually with 5 submarginal setae in an irregular row, most basal submarginal weak and short, the remaining setae strong, subequal in length. *Subapical Lobe*. Rodlike setae *a-c* stronger; distal part with several long fine hairlike setae which are densely packed at bases of setae *d-f* and leaflet g_2. *Phallosome*. Well sclerotized; external process moderately broad with several strong, dark denticles on upper tergal surface.

PUPA. As described and figured for *peytoni* (Fig. 50), differing from it particularly in the following characters. *Cephalothorax.* Seta 1-C 4 branched; 5-C 3, 4 branched. *Abdomen*. Setae 3-I, II usually single, sometimes double; 6-III-V usually triple (2-4); 9-VIII 5-7 branched.

LARVA (Fig. 52). Differing from *peytoni* in the following combination of characters. *Head*. Seta 5, 6-C flattened and relatively short; 5-C double; 6-C always single; 7-C weaker and shorter, 4-9 branched. Antenna shaft with considerably weaker and fewer spicules. *Thorax*. Spiculation absent or inconspicuous; seta 7-P usually double, sometimes single. *Abdomen*. Seta 6-I usually triple, sometimes 4 branched; 6-III, IV usually triple (2-4); 6-V, VI double; 1-III-VI weak and short, 3, 4 branched. Seta 2-X of saddle usually double, sometimes single. *Siphon*. Relatively thick, covered with numerous minute, dotlike spicules; distal pecten teeth with weaker basal denticles; subventral tufts weaker and shorter, usually 4 pairs, sometimes with 1 additional tuft distad of pecten; pairing very irregular, 3, 4 branched each; most proximal pair longest, about 1.5 times as long as siphonal width at point of attachment, the remaining pairs gradually shorter.

TYPE-DATA. Holotype ♂* (0181-11) with associated larval and pupal skins and slide of antenna and genitalia, Huey Bong Ti, *Kanchanaburi*, THAILAND, rock hole, 2 June 1965, K. Mongkolpanya (USNM; No. 69183).

DISTRIBUTION. Known only from Thailand. 146 specimens examined: 28♂, 23♀, 95 L; 48 with associated immature skins (31 p, 17 lp).

THAILAND. *Nan:* Doi Chick Chong; Ban Pha Man; *Kanchanaburi:* Sai Yok Waterfall; Ko Chum Rong Village; Huey Mae Nam Noi; Ban Sai Yok; Huey Bong Ti (type-locality); Khao Saeng; Khao Nga Chang; *Chanthaburi:* Khao Wong, Tha Mai; *Phangnga:* 28♂, 23♀, 95 L, 31 p, 17 lp.

TAXONOMIC DISCUSSION. *Culex eukrines* is particularly known from Kanchanaburi, Thailand where the types and numerous topotypic specimens were originally and subsequently collected. Its distribution is very localized and apparently more restricted than that of *peytoni*. Except for records from Thailand, this species is not known elsewhere in Southeast Asia.

Although the males of *eukrines* and *peytoni* slightly differ from each other in the antenna and genitalia, their differences in the larvae are clear-cut and constant, as indicated in the key and in the above description. The most diagnostic features of the *eukrines* larvae are the single flattened seta 6-C and the reduction in size of the spicules of the antennal shaft. In the males, *eukrines* differs from *peytoni* in the reduction of the modified tufts of the antenna and in the presence of several densely packed long hairlike setae associated with seta *d-f* of the subapical lobe of the basimere of the genitalia. The difference in the breeding sites of *eukrines* and *peytoni* are also well marked; somewhat resembling that between those of *minor* and *bicornutus; eukrines* apparently exhibits a tendency to breed in rock holes or pools instead of bamboos or tree holes, whereas the reverse is true of *peytoni*.

All of the specimens of *eukrines* which I have examined essentially conform to the above descriptions except for a single larva from Ban Pha Man in

Nan (Coll. 01439, from a crab hole) which differs from the typical form in having strong spicules on the antenna and in having 1, 2 simple or undenticulate pecten teeth distad of normal teeth of the siphon. Without the associated adult male, this larva is tentatively identified with *eukrines* although it is possible that it may represent a distinct species.

BIONOMICS. The immatures of *eukrines* have been frequently collected from rock holes or pools along the margin of mountain streams under heavy or partial shade of tropical forest. Of the 14 larval collections made in Thailand, 8 were from rock pools, 2 from tree holes and one each from bamboo, a coconut shell, a wheel track and a crab hole. The larvae from rock pools were abundant and have been collected in numbers at several localities in Kanchanaburi. All adults apparently came from rearing the larvae or pupae.

pholeter complex

43. *CULEX (LOPHOCERAOMYIA) PHOLETER* BRAM AND RATTANARITHIKUL (Figs. 53, 54)

Culex (Lophoceraomyia) pholeter Bram and Rattanarithikul 1967: 13 (♂*, ♀, L*); Bram 1967a: 103 (♂*, ♀, L*).

FEMALE. Wing: 2.7 mm. Forefemur: 1.5 mm. Proboscis: 1.8 mm. Relatively small species with general external features exceedingly similar to *mammilifer* and *bengalensis*, differing in the following characters. *Head*. Decumbent scales on anterior margin of vertex relatively broader, pale whitish, forming a broad ocular line; narrow decumbent scales restricted to center, rather coarse, crescent-shaped and predominantly dark; erect scales usually entirely dark, sometimes partially pale yellowish on posterolateral area; lateral patch of broad scales whitish. *Cibarial Armature*. Very distinctive; cibarial bar with a concave row of about 18 teeth, 4 median teeth narrow, tapering into sharp points, remaining lateral teeth broad, flattened, apically blunt or truncate. *Thorax*. One lower *mep* bristle present. *Wing*. Scales on all veins more numerous and rather dense. *Abdomen*. Sterna yellowish white scaled, contrasting sharply with entirely black scales on terga.

MALE. Very similar to *mammilifer*, differing from it in the following characters. *Palpus*. Rather short, varying from slightly shorter to as long as proboscis; segments 4, 5 reduced in length, each with only a few short bristles. *Antenna*. Flagellar whorls weakly to moderately plumose; modified tuft of F-5 composed of 3-5 dark scales which are variable from narrow, linear or lanceolate to broad, abruptly acuminate, as long as the combined length of the next 2, 3 flagellomeres; dorsalmost scale usually broad, apically blunt or pointed; remaining scales narrow, hairlike or lanceolate; modified tufts of F-6-8 well developed, as in *mammilifer;* F-9 with 3, 4 weaker bristlelike setae.

MALE GENITALIA (Fig. 53). As described and figured by Bram and Rattanarithikul (1967: 13); essentially conforming to the *Mammilifer* Subgroup with the following diagnostic features. *Segment IX*. Tergal lobe very poorly developed, bearing 1-3 tiny setae; sternum with a transverse row of 5 strong setae towards caudal margin. *Basimere*. Inner tergal surface with a linear row of 3 submarginal setae near base; marginal setae and other short setae laterad of submarginals and subapical lobe very sparse and weak. *Subapical Lobe*. Rodlike seta *a* short, distally tapered into a sharp point, its length 0.50-

0.75 of rods *b, c;* the latter very slender, rather long and apically hooked; setae *d-f* rather narrow and weak; leaflet g_1 very broad, long and striated, its apex blunt or acuminate; seta *h* moderately strong. *Distimere*. Dorsal surface with distinct ridges or folds distad of median curvature; dorsal subapical crest of spicules absent. *Phallosome*. Poorly sclerotized, as in *peytoni;* internal process rather short or markedly reduced in size; external process broad, with 2 irregular rows of several distinct denticles on upper tergal surface; apical spiculose lobe (or knob) very small and short. *Proctiger*. As in most forms, 2 cercal setae present.

PUPA (Fig. 53). Abdomen: 2.7 mm. Paddle: 0.6 mm. Trumpet: 0.55 mm; index 10-15. Cephalothorax and abdomen pale whitish to yellowish. *Trumpet*. Dark, slender; apical portion distad of proximal annulation of meatus strongly spiculate; pinna with distinct slit extended to meatus. Complete chaetotaxy as figured, distinctive in the following. *Cephalothorax*. Seta 5-C very strong, 2-3 times as long as 7-C, usually double (2-3); 8-C double; 9-C usually double (1-2). *Metanotum*. Seta 10-C usually double (2-3); 11-C double. *Abdomen*. Setae 3-I-III double; 5-IV usually double (2-3), 1.5 times as long as segment following; 5-V, VI single, very strong, 2 times as long as segment following; 6-III-VI usually double (2-3); 9-VII usually triple (3-4); 9-VIII strong, twice longer than 9-VII, 4-8 branched, 3, 4 median branches reaching 0.5 of paddle length. *Paddle*. Broad, pale whitish to almost transparent; midrib weak and lightly pigmented.

LARVA (Fig. 54). Head: 0.78 mm. Siphon: 1.2-1.8 mm; index 7. Saddle: 0.30 mm; siphon/saddle ratio 5. As figured by Bram and Rattanarithikul (1967: 8) and Bram (1967a: 104); in general similar to most forms, but with the following diagnostic features. *Head*. Integument pale yellowish or cream-colored; seta 1-C simple, pale yellow or dark; 4-C variable from 1.2-2.5 times as long as distance between bases of the pair; 5, 6-C strong, subequal, double; 7-C 5-8 branched. Antennal shaft pale, cream-colored or slightly darkened; spicules strong and dark. *Thorax*. Spiculation absent; seta 7-P usually double, sometimes triple; 8-P minute, 2-5 branched, of the same magnitude as 14-P; the latter usually double, sometimes triple. *Abdomen*. Spiculation absent; setae 6-I, II and 7-I dark, stout; 6-I, II usually with 2 long lateral branches and 1 short median branch, sometimes median branch absent or not developed; 7-I double; 6-III-VI usually double (1-3); 1-III-VI variable in length, usually single or double, sometimes triple. Comb scales rather numerous, usually 60 or more, sometimes fewer; all scales with normal apical fringe of evenly fine spicules. Saddle weakly spiculate on posterior caudal margin; pale yellowish, sometimes slightly darker; seta 2-X usually double (2-3), shorter branch nearly as long as longer branch; 2 proximal pairs of setae of ventral brush more or less detached from grid; anal gills as long as saddle. *Siphon*. Moderately long, pale yellowish or same color as head capsule; pecten teeth 8-10, larger distal teeth with 1, 2 strong basal denticles and 5, 6 finer distal denticles; subventral tufts 4 pairs, each usually double (1-2), sometimes 4, 5 branched, length variable, usually weak and short, sometimes very strong and long; most proximal pair distad of pecten as long as siphonal width at point of attachment, the remaining pairs gradually reduced in length; median caudal filament of spiracular apparatus present.

TYPE-DATA. Holotype ♂* (00416-2) with associated larval and pupal skins and slide of antenna and genitalia, Khao Mai Ha Wa, *Chon Buri:* THAILAND, from a crab hole in a mountainous secondary rain forest, 19 July 1965, E. L. Peyton (USNM; No. 69184).

DISTRIBUTION. Known only from Thailand. 88 specimens examined:

14♂, 7♀, 67 L; 18 with associated immature skins (13 p, 5 lp).

THAILAND. *Chon Buri,* Khao Mai Ha Wa (type-locality). Bang La Mung, Khao Mai Kaeo; Khao Sai Dao; *Nakhon Ratchasima:* Khao Suan Hom; Khai Phai; 14♂, 7♀, 41 L, 13 p, 5 lp; *Ranong:* Ban Chatri; *Phangnga:* Thap Wen; Nam Tai; Tang Mai; 26 L.

TAXONOMIC DISCUSSION. *Culex pholeter* is apparently very variable, but can be readily recognized in the male, male genitalia, pupal and larval stages by the characters as given in the keys and as indicated in the above diagnosis. In addition, *pholeter* also appears to be rather distinct ecologically. It differs from almost all other species of the *Mammilifer* Subgroup in having a tendency to breed in crab holes in preference to other types of breeding sites, including general ground pools. Most of the larvae from Thailand came from crab holes except for those from Ranong and Phangnga, which were collected in cut bamboo lying on the ground and bamboo stumps. The material from bamboo differs slightly or strongly from that in the crab holes in the darker pigmentation and in having stronger and more numerous branched subventral tufts of the siphon. It is likely that more than one form is involved. However, as the bamboo material consists only of whole larvae, they are here tentatively identified as *pholeter,* pending further study of associated males when they become available.

Because of the distinctive male characters, including the genitalia, *pholeter* appears to belong to a distinct complex of the *Mammilifer* Subgroup. Its affinity is not clear and cannot be accurately determined, but it appears to be intermediate between the *mammilifer* and *peytoni* complexes. In the male, the modified tuft of antennal flagellomere 5 somewhat resembles that of *mammilifer* but is less developed. The male genitalia is more or less similar to *peytoni* but the internal process of the phallosome is more strongly reduced in length and size. In the immatures, the pupa resembles *mammilifer* in the trumpet by having pinna slit extended to meatus and double seta 11-C but is similar to *peytoni* in the development and branching of seta 5-IV-VI. The larva is the most diagnostic stage, particularly in having seta 8-P strongly reduced to the magnitude of seta 14-P; otherwise it resembles *peytoni* in general and detailed chaetotaxy.

BIONOMICS. The larvae and pupae of *pholeter* from Chon Buri and Nakhon Ratchasima were mostly collected in crab holes on the bank of mountain streams at elevations of 150-1,400 m. On occasion, they were also taken in stream pools, tree holes and foot prints. Of the 20 larval collections made at the above localities; 13 were from crab holes, 4 from stream pools, 2 from tree holes and one from a foot print. Most of the larvae from Ranong and Phangnga were collected in split bamboos lying on the ground and only a few from bamboo stumps, at an elevation of 100-200 m.

flavicornis complex

44. *CULEX (LOPHOCERAOMYIA) FLAVICORNIS* BARRAUD
(Figs. 55, 56)

Culex (Lophoceratomyia) flavicornis Barraud 1924: 45 (♂*, ♀); Edwards 1932: 198 (taxonomy); Barraud 1934: 375 (♂*, ♀).

FEMALE. Wing: 4.7 mm. Forefemur: 2.3 mm. Proboscis: 2.7 mm. As described by Barraud (1924: 45; 1934: 375-6); in general essentially con-

forming to the *Mammilifer* Subgroup with the following diagnostic features. Size medium to large. *Head*. Decumbent scales of vertex entirely narrow and pale yellowish; erect scales slender, entirely blackish and moderately dense. *Cibarial Armature*. Cibarial bar with a concave row of 50-60 narrow, elongate teeth which are subequal in size and length and distally tapered into a fine point. *Thorax*. Mesonotal scales predominantly blackish except for some pale yellowish ones on extreme anterior promontory. Lower *mep* bristle absent. *Legs*. Entirely blackish except for anterior surface of hindfemur which is entirely pale whitish in basal 0.4-0.5, continuing as narrow pale stripe in apical 0.5-0.6. *Wing*. Scales on veins R_2, R_3 and R_{4+5} narrow, linear. *Abdomen*. Terga entirely dark; sterna pale yellowish.

MALE (Fig. 55). In general as in female, differing in smaller size. *Palpus*. Long, exceeding proboscis length by about 0.75 of the length of segment 5; segments 2, 3 with several rows of numerous long, hairlike setae on ventral and mesal surfaces, longest ones about 4, 5 times as long as segment width at point of insertion; lateral surface of segment 3 with a distinct row of 15-20 dark, long hairlike setae extending from base to apex; segments 4 and 5 upturned, with several short, weak setae and a few bristles; segment 5 elongate, about 2 times as long as segment 4. *Proboscis*. Lightly swollen in basal 0.2-0.5 and with a double row of 12-16 strong setae on ventral surface. *Antenna*. Pedicel with a strong spiculose prominence on inner dorsal surface; flagellar whorls weakly to moderately plumose; modified tufts of scales and setae present on F-5 to F-9; F-5 with a large, brushlike yellowish or golden tuft of 12-15 equally long fine hairlike setae which are as long as the combined length of the next 5, 6 flagellomeres; F-6, 7 with strong, dark, crumpled tufts of curled setae as described for most forms; F-8 with a strong sigmoid hooked tuft as in *mammilifer* and *minor;* F-9 with a dark tuft of 4-6 strong bristlelike setae; proximal portions of F-9-11 with 1-3 short, weak setae distad of whorls.

MALE GENITALIA (Fig. 55). *Segment IX*. Tergal lobe with 3, 4 relatively strong setae; sternum with several strong setae towards caudal margin. *Basimere*. Rather large, about 0.30 mm in length; basal portion broad, outer tergal margin strongly convex or swollen, apical portion narrow; inner tergal margin (or surface) strongly concave, with a close-set row of 8, 9 strong, flattened submarginal setae; marginal setae 5, 6, strong, about 0.2 of submarginals, placed among the latter; short setae laterad of submarginals weak and sparse. *Subapical Lobe*. Prominent; rod *a* very thick with characteristic expanded twisted apex resembling a hammer head; rods *b*, *c* slender and apically hooked, distal portion of *b* somewhat wavy or kinked; leaflet g_2 with characteristic striation, resembling a tree leaf; seta *h* moderately strong; leaflet g_1 rodlike, distally curved and apically hooked; setae in group *d-f* represented by one fine blade, placed close to leaflet g_1. *Distimere*. Very thick, with modified, broadly expanded truncate apex; median curvature pronounced; subapical dorsal surface recurved, with distinct crest of fine spicules; ventral tiny seta present, dorsal one absent; claw small, slender, placed almost at tip of the recurved apex. *Phallosome*. Well sclerotized; lateral plate with a short, simple internal process and a weakly, denticulate external process, the latter with a distinct spiculose apical lobe sternad and 15-17 weak denticles in 2, 3 irregular rows on upper tergal surface. *Proctiger*. Apical crown medium sized, with several flat and blunt spicules laterally and numerous finer spinelike spicules mesally (or internally); paraproct and cercal sclerite moderately broad, well sclerotized; 3 minute cercal setae.

PUPA (Fig. 56). Abdomen: 2.9 mm. Paddle: 0.90 mm. Trumpet: 0.75 mm; index 10. Cephalothorax brownish on wing, leg and labial cases, head

shield and area along mid-dorsal ridge, pale yellowish on other areas; metanotum brownish; abdomen largely brownish on segments I-III, pale cream-colored on segments IV-VIII. *Trumpet*. Dark brown, cylindrical and long; pinna with slit extending to meatus. Complete chaetotaxy as figured; in general conforming to the *Mammilifer* Subgroup, distinctive in the following. *Cephalothorax*. Seta 1-C usually 4 branched (3-5); 5-C usually 5 branched (3-6), subequal to 7-C; 8-C 2-5 branched; 9-C usually triple (1-3). *Metanotum*. Seta 10-C usually 3, 4 branched (2-4); 11-C always double. *Abdomen*. Setae 3-I-III double; 5-IV-VI double, 5-IV, V subequal, 1.5 times as long as segment following, 5-VI slightly shorter; 6-III-VI usually 3, 4 branched (2-5); 9-VII, VIII weak, subequal; 9-VII usually double or triple (2-4); 9-VIII usually 6, 7 branched (5-8); 4-VIII double. *Paddle*. Broad, pale whitish, with characteristic bluntly pointed apex, somewhat resembling a leaf; midrib weak and pale; apical portion minutely spiculate; setae 1, 2-P present, distinct.

LARVA (Fig. 56). Head: 0.75 mm. Siphon: 1.9 mm; index 11; saddle: 0.36 mm; siphon/saddle ratio 5.5-6.0. Essentially conforming to the *Mammilifer* Subgroup, distinctive in the following features. *Head*. Setae 5, 6-C double; 14-C double or triple. Antennal shaft yellowish brown with numerous strong spicules. Mental plate with 8, 9 lateral teeth on each side of median tooth. *Thorax*. Lightly spiculate, sometimes spiculation not developed or indistinct; setae 7, 8-P subequally strong, double; 14-P single; 1-M as long as or longer than 3-M, single; 8, 9-M 4, 5 branched; 1-T longer than 2-T, single; 7-T 5-7 branched; 9-T 5 branched; 13-T 4, 5 branched. *Abdomen*. Spiculation absent; 6-I, II and 7-I dark, stout; 6-I, II usually triple (2-3); 7-I usually double (1-2); 6-III-VI triple; 1-III-VI strong, nearly as long as 6-III-V, usually 4 branched (3-4); 13-III-V shorter than 1-III-VI, 4 branched. Comb scales numerous, 50-60, all apparently subequal, with normal fringe of evenly fine spicules. Saddle yellowish brown, posterior caudal margin weakly spiculate; seta 2-X double; anal gill shorter or as long as saddle. *Siphon*. Relatively long and slender, distally slightly tapered; yellowish or same color as saddle; pecten teeth 13-18, median teeth with a strong basal denticle and 3-5 finer distal denticles; 4, 5 distal teeth rather widely spaced, with or without a fine barb of 3-5 graded denticles; subventral tufts 4 pairs, all weak, subequal, usually double, 1.0-1.5 times as long as siphonal width at point of attachment; median caudal filament of spiracular apparatus well developed.

TYPE-DATA. Lectotype ♂*, Nilgiri Hills, Kasauli, *Madras*, INDIA, October 1915, Khazan Chand (BMNH; selection of Bram 1967b: 328).

DISTRIBUTION. Known only from India. 10 specimens examined: 6♂, 4♀; 6 with associated immature skins (1 p, 5 lp).

INDIA. *Madras:* Kasauli; Nilgiri Hills; 6♂ (including lectotype), 4♀, 1 p, 5 lp. Also reported from Kodaikanal, Palni Hills by Barraud (1934: 376).

TAXONOMIC DISCUSSION. *Culex flavicornis* is strongly differentirated from all other species in the *Mammilifer* Subgroup in the male by the prominent rows of numerous fine setae and bristles on the ventral, lateral and mesal surfaces of palpal segments 2 and 3 and the large, yellowish or golden brush-like tuft of long setae on antennal flagellomere 5; and in the male genitalia by the shape of the basimere, the modified apex of distimere, the setae and leaflets of the subapical lobe, the reduction of the internal process of the phallosome and the relatively coarse spicules of the proctiger crown. The female is generally very similar to most species but can be recognized by the absence of a lower mesepimeral bristle and by the presence of 50-60 narrow fine teeth in the cibarial armature. The pupa somewhat resembles *tuberis* in having the apex of the paddle more or less pointed but differs from it in the darker pig-

mentation of cephalothorax, pinna of trumpet with slit extending to meatus, setae 5-IV-VI double and 6-III-VI usually 3, 4 branched. The larva closely resembles *mammilifer* in having seta 8-P double and 14-P single but differs from it in the darker pigmentation, setae 1-III-VI usually 4 branched and siphon with 4 pairs of subventral tufts.

Within the *Mammilifer* Subgroup, *flavicornis* is apparently most closely similar to *raghavanii* Rahman, Choudhury and Kalra (1968 (1969): 28-34). Both were described from the same locality in the Nilgiri Hills, Madras, India. However as I have not seen the specimens of the latter, it is not possible to determine whether or not it is really distinct from *flavicornis*. From the figures and descriptions by the above authors, *raghavanii* apparently differs from *flavicornis* in the male genitalia by having unmodified apex of distimere, different shape of leaflet g_1 of the subapical lobe and in the larva by the heavily spiculose thorax and abdomen. It is possible that the larva of *raghavanii* is incorrectly associated and belongs to *uniformis*.

BIONOMICS. *Culex flavicornis* is restricted to high elevations in mountainous areas. At Palni Hills, Kodaikanal, India, it was recorded from an elevation of 7, 000 ft. (approximately 2, 300 m) (Barraud 1934: 376). In the Nilgiri Hills, Madras, the larvae have been collected from rock pools, containing numerous fallen leaves under heavy shade of a tropical forest. They were found in association with larval specimens of *Culex (Culiciomyia) pallidothorax* Theobald.

45. *CULEX (LOPHOCERAOMYIA) LASIOPALPIS* NEW SPECIES
(Fig. 57)

FEMALE. Wing: 2.18 mm. Forefemur: 1.44 mm. Proboscis: 1.7 mm. Small, slender, blackish species; in general similar to *flavicornis* in the absence of a lower *mep* bristle, differing in smaller size and in the following features. *Head*. Narrow decumbent scales on anterior margin of vertex broader and pale whitish, scales in the center blackish. *Cibarial Armature*. Cibarial bar with a concave row of 30-34 teeth, lateral ones apparently coarser or more flattened with abruptly pointed apices.

MALE (Fig. 57). Essentially similar to *flavicornis* in the antennal modified tufts and in the presence of numerous densely packed hairlike setae on lateral, ventral and mesal surfaces of palpal segments 2 and 3, differing from it as follows. *Palpus*. Shorter, exceeding proboscis by about 0. 5 of segment 5; segments 4, 5 subequally long. *Proboscis*. Uniformly thin with fewer setae on ventral surface. Antenna. F-5 with a smaller yellowish or golden brushlike tuft of 8-10 long setae.

MALE GENITALIA (Fig. 57). As figured, differing from *flavicornis* strikingly in the following features. *Basimere*. Normal, slender, conical, about 0. 2 mm in length; submarginal seta weaker and shorter, 5-7 in number. *Subapical Lobe*. Rod *a* distally tapering into a point; rodlike seta g_2 more slender; setae in group *d-f* consist of 1, 2 fine setae, 1 strong, serrate blade and 2 other shorter and simple blades; leaflet g_1 simple, broad lanceolate, apical foliate portion unstriated. *Distimere*. Slender, normal, apex unmodified; dorsal subapical crest absent. *Phallosome*. Apical spiculose lobe of external process reduced or poorly developed; upper tergal surface of external process with about 15 strong denticles in a dense triple row. *Proctiger*. Apical crown smaller and with fewer spicules; paraproct and cercal scerite narrower.

PUPA (Fig. 57). Abdomen: 2.2 mm. Paddle: 0. 52 mm. Trumpet: 0. 57

mm; index 10-12. Complete chaetotaxy as figured, differing from *flavicornis* in the following. *Trumpet*. Thinner. *Metanotum*. Seta 10-C always double. *Abdomen*. Seta 5-IV usually triple (2-4); 6-II-VI usually 4 branched (4-6). *Paddle*. Apex evenly rounded or slightly produced.

LARVA. Head: 0.65 mm. Siphon: 1.44 mm; index 10. Saddle: 0.29 mm; siphon/saddle ratio 5. As figured and described for *flavicornis*, differing from it in the following features. All setae apparently weaker. *Thorax*. Spiculation absent. *Abdomen*. Spiculation absent; seta 1-II triple; 1-IV-VI 4 branched. Comb scales 40-50. *Siphon*. Shorter with lower index and siphon/saddle ratio; pecten teeth 10-12, all with fine barb of 6,7 graded denticles; subventral tufts weaker, 3 pairs, more widely spaced, as long as or slightly longer than siphon width at point of insertion.

TYPE-DATA. Holotype ♂ (126-8) with associated pupal and larval skins and slide of antenna and genitalia, Matale, Matale District. *Central Province*, SRI LANKA, foot print in seepage, elevation 915 m, 26 June 1975, E. L. Peyton and Y.-M. Huang (USNM). Allotype ♀ (126-9) with associated pupal and larval skins and slide of cibarial armature (USNM); paratypes: 1 lp♀ (126-6), 2 p♂ (126-101, 117), 1 p♀ (126-104), same data as holotype; 1 lp♂ (220-3), 6 L (220); 1 lp♂ (221-8), 4 L (221), Kanneliya, Galle District, *Sabaragamuwa Province*, elephant foot print in marshy depression, elevation 245 m, 10 July 1975, other data as in collection No. 126 (USNM, BMNH).

DISTRIBUTION. Known only from Sri Lanka. 18 specimens examined: 5♂, 3♀, 10 L; 8 with associated immature skins (3 p, 5 lp), as indicated in the type-data.

TAXONOMIC DISCUSSION. *Culex lasiopalpis* is provisionally recognized as distinct from *raghavanii* Rahman, Choudhury and Kalra (1968 (1969): 28-34) from the Nilgiri Hills, Madras, India, pending a thorough comparison with the type-male of the latter. The male of *lasiopalpis* apparently agrees well with the description and figure of *raghavanii* in the features of antenna and palpus and in several details of the genitalia, but differs from it in having simple, broad lanceolate leaflet g_1 of the subapical lobe (broad, triangular in *raghavanii*) and in the presence of 5-7 submarginal setae on the basimere (8-9 in *raghavanii*). In the immature stage, the pupa of *lasiopalpis* differs from the description and figure of *raghavanii* in the evenly rounded apex of the paddle (pointed in *raghavanii*); the larva differs in the absence of the spiculation on the thorax and abdomen and in the presence of 3 pairs of the subventral tufts of the siphon (4 pairs in *raghavanii*). As discussed under *flavicornis*, the association of the adults and immature stages of *raghavanii* may possibly be incorrect and certain features of its male genitalia were perhaps erroneously described. A detailed study of the type and additional topotypic specimens of *raghavanii* are critically needed to definitely establish its identity.

Culex lasiopalpis is most closely related to *flavicornis* and evidentally falls into a complex with the latter species. It can be readily separated from *flavicornis* in the male, pupa and larva by the features as given in the keys and in the above description.

BIONOMICS. *Culex lasiopalpis* is apparently rare. In Sri Lanka the immatures have been taken twice, from animal foot prints in a seepage and from a marshy depression under partial shade of tropical rain forests, both in mountainous areas at elevations of 915 m and 245 m. All adults came from rearing pupae and larvae.

Brevipalpus Subgroup

The *Brevipalpus* Subgroup is characterized in the adults by the color of erect scales of vertex varying from entirely dark to partially pale golden or bronzy in center, dark on posterolateral areas; lower *mep* bristle absent; in the female cibarial armature by the presence of 15-25 coarse teeth (except *jenseni*); in the male by the relatively short palpus which is usually from 0.50-0.75 of proboscis length, although sometimes as long as or slightly longer than proboscis; in the male genitalia by (1) basimere varying from small, slender, conical to large, stout or modified, without prominent row of submarginal setae; (2) setae of subapical lobe as described for the group or strongly differentiated in number and shapes; leaflet g_1 usually absent, sometimes present; (3) distimere normal or with strongly modified apex; (4) internal process of phallosome poorly or well developed; in the pupa by trumpet relatively short, bell-shaped or funnel-shaped, varying from 0.2-0.4 mm in length and in the larvae by (1) seta 2, 3-A placed apically on the antenna; (2) setae 16, 17-C absent; (3) siphon slender or thick, length varied from shorter than to 2-3 times as long as saddle and (4) subventral tufts of siphon usually 6-8 pairs (total 16), sometimes 3. Breeding habitats: exclusively pitcher plants.

DISCUSSION. The *Brevipalpus* Subgroup comprises several highly specialized forms whose breeding habitats are restricted to pitcher plants. Certain members of this subgroup, including particularly *jenseni*, *navalis* and *coerulescens* are morphologically closer to the members of the *minor* complex than any others in the *Mammilifer* Subgroup. The group as a whole appears to be an offshoot from the latter through specialization in the breeding habitats. In the Oriental region, the *Brevipalpus* Subgroup is largely restricted to Malaysia (including Peninsular Malaysia and Borneo), Singapore and other neighboring islands in Indonesia with only a few extending into the north in Thailand, Vietnam and Hong Kong.

All 10 species in the *Brevipalpus* Subgroup are apparently well known except for *sumatranus* Brug which had not, until recently been transferred from *Neoculex* to *Lophoceraomyia* by Sirivanakarn (1971). They can be readily classified into 5 more or less distinct complexes: *navalis*, *hewitti*, *jenseni*, *brevipalpus* and *curtipalpis* as characterized below.

(1) *navalis* complex, represented by *navalis* and *coerulescens*. It is characterized in the male by (1) palpus as long as or longer than proboscis and (2) modified tufts of scales and setae on antennal flagellomeres 5-9 well developed, as described for the *Mammilifer* Group; in the male genitalia by (1) basimere small, conical, with 1 strong submarginal seta or none; (2) subapical lobe with 3 rodlike setae in group *a-c*, 3 bladelike setae in group *d-f*, and 1 basal seta *(h);* leaflet g_1 absent and (3) distimere slender, normal; in the pupa by (1) trumpet funnel-shaped, 0.40-0.45 mm in length; (2) seta 8-C weak, double; (3) seta 5-IV 2-4 branched and (4) 9-VIII 7, 8 branched; in the larva by (1) antenna nearly as long as head length; (2) seta 1-A strongly plumose, 15 or more branched; (3) seta 1-C dark, spiniform; (4) setae 5, 6-C long, single or double; (5) comb scales numerous, 30-35; (6) siphon slender, lightly swollen in middle, 2-3 times as long as saddle and (7) subventral tufts of siphon 7, 8 pairs.

(2) *hewitti* complex, including only *hewitti*. It is characterized by the male by (1) palpus 0.9 of proboscis length; (2) modified tufts of antennal flagellomeres 5-9 minute or rudimentary; and (3) F-6 with a characteritstic tuft of 2-4

subapically swollen setae; in the male genitalia by (1) basimere and subapical lobe as in *navalis* complex except for the absence of submarginal seta and (2) distimere thick, with modified truncate apex; in the pupa by (1) trumpet as in *navalis* complex; (2) seta 8-C usually triple; (3) 5-IV long, single and (4) 9-VIII 8 branched; in the larva by (1) antenna nearly as long as head; (2) seta 1-A weakly plumose, 9-11 branched; (3) seta 1-C pale, spiniform; (4) setae 5-C 5-9 branched, 6-C single; (5) comb scales 50; (6) siphon slender, distally tapered, about 4 times as long as saddle and (7) subventral tufts of siphon 7 pairs.

(3) *jenseni* complex, represented only by *jenseni*. It is intermediate, resembling the *navalis* complex in the male, including the genitalia, but is similar to the *brevipalpus* complex in the pupa and larva. It is characterized in the male particularly by palpus 0.6-0.7 of proboscis length; in the male genitalia by subapical lobe and distimere as in *navalis* complex; in the pupa by (1) trumpet somewhat oval or oblong in shape, 0.3-0.4 mm in length; (2) seta 8-C single; (3) seta 5-IV single and (4) 9-VIII 5-7 branched; in the larva by (1) seta 1-A weak, 3-6 branched; (2) seta 1-C dark, stout, spiniform; (3) setae 5, 6-C long, each 2-4 branched; (4) comb scales 24-27 in number; (5) siphon thick, relatively short, 1.7-1.8 of saddle length and (6) subventral tufts very strong, 6, 7 pairs.

(4) *brevipalpus* complex, represented by *brevipalpus*, *lucaris*, *eminentia* and *acutipalus*. It is characterized in the male by (1) palpus 0.50-0.75 of proboscis length and (2) modified tufts on antennal flagellomeres 5-9 well developed, as in *navalis* and *jenseni* complexes; in the male genitalia by (1) basimere broad, stout, somewhat rectangular in lateral aspect, submarginal seta not developed; (2) subapical lobe broad, strongly differentiated, with numerous strong setae associated with rods *a-c* and setae *d-h*, leaflets absent and (3) distimere with modified truncate apex; in the pupa by (1) trumpet bell-shaped, 0.25-0.30 mm in length; (2) seta 8-C strong, single; (3) seta 5-IV long, single and (4) seta 9-VIII long, single; in the larva by (1) antenna short, about 0.5 of head length; (2) seta 1-A weak, 4-6 branched; (3) seta 1-C pale, distally filamentous; (4) setae 5, 6-C markedly flattened and short, placed cephalad, 5-C 2-4 branched, 6-C single; (5) comb scales 20-30; (6) siphon thick, 2-3 times as long as saddle and (7) subventral tufts strong, 6-9 pairs.

(5) *curtipalpis* complex, represented by *curtipalpis* and *sumatranus*. It is characterized in the male by (1) palpus 0.5 of proboscis length and (2) modified tufts of scales and setae present on antennal flagellomeres 5-9 or completely absent; in the male genitalia by (1) basimere broad, stout, somewhat oval, without differentiated submarginal setae; (2) subapical lobe with a broad external leaflet (g_1) in addition to usual specialized setae as in *navalis* complex and (3) distimere thick, with modified truncate apex; in the pupa by (1) trumpet short, small, typically bell-shaped, 0.3 mm in length; (2) seta 8-C single; (3) seta 5-IV single, moderately long and (4) seta 9-VIII 4, 5 branched; in the larva by (1) antenna short, about 0.5 of head length; (2) seta 1-A weak, 3, 4 branched; (3) seta 1-C short, stout, pale, spiniform, placed on distinct tubercle; (4) setae 5, 6-C short, fine, placed cephalad, each 2-4 branched; (5) comb scales 5-8 and (6) siphon markedly reduced, about 0.75 of saddle and (7) subventral tufts of siphon weak, 3 pairs.

navalis complex

46. *CULEX (LOPHOCERAOMYIA) NAVALIS* EDWARDS
(Figs. 58, 59)

Culex (Lophoceratomyia) navalis Edwards 1926: 121 (♂*, L); Edwards 1928: 277 (♂*); Edwards and Given 1928: 353 (L*); Edwards 1932: 198 (taxonomy); Brug and Bonne-Wepster 1947: 186 (distribution).
Culex (Lophoceraomyia) navalis Edwards, Mattingly 1949: 226 (L*); Stone, Knight and Starcke 1959: 235 (catalog); Colless 1965: 304 (♂*, ♀, L).

FEMALE. Wing: 3.0 mm. Forefemur: 1.6 mm. Proboscis: 1.9 mm. Small, slender, blackish species; essentially conforming to the *Brevipalpus* Subgroup characters. *Head*. Decumbent scales of vertex entirely narrow, linear, scales on upper anterior margin pale whitish, forming a distinct ocular line; scales in the center yellowish brown or golden to black; all erect scales black; lateral patch of broad scales whitish or grayish. *Cibarial Armature* (Fig. 58). Cibarial bar with concave row of about 20 stout teeth; 3-4 median teeth narrow with apices tapered into sharp point; lateral teeth widely spaced with abruptly pointed or truncate apices. *Thorax*. Pleuron without scale patches; lower *mep* bristle absent; *ppl* with 2 strong dark bristles and a few yellowish short setae. *Legs*. Anterior surface of hindfemur with a distinct white stripe extending from base to apex, rest entirely blackish. *Wing*. Scales very narrow, linear and moderately dense. *Abdomen*. Terga entirely black scaled; sterna pale yellowish or silvery white scaled.

MALE (Fig. 58). Exceedingly similar to members of *Mammilifer* Subgroup, differing slightly in the following characters. *Palpus*. Usually as long as proboscis, sometimes slightly longer. *Proboscis*. Uniformly thin and slender. *Antenna*. Spiculose prominence of pedicel strong and distinct; flagellar whorls moderately to strongly plumose; F-5 with a distinct yellowish or golden tuft of 4, 5 long, narrow, somewhat lanceolate scales, as long as the next 2 flagellomeres, preceded dorsally by 2 short fine, hairlike setae; F-6, 7 with strong, dark, crumpled tufts of curled setae as in members of the *Mammilifer* Subgroup; F-8 with a typical sigmoid hooked tuft of 6, 7 fused setae; F-9 with a prominent dark tuft of 6, 7 strong bristlelike setae; F-9-11 without any setae distad of normal whorls of long setae.

MALE GENITALIA (Fig. 58). As figured. *Segment IX*. Tergal lobe very poorly developed, bearing 1, 2 minute, hairlike setae; sternum with 6 strong setae in an irregular transverse row towards caudal margin. *Basimere*. Slender, normal, conical, about 0.2 mm in length; inner tergal surface with or without 1 strong submarginal seta near base; marginal setae sparse and weak; stronger bristles largely restricted to lateral tergal surface, median lateral area with relatively small number of short and weak setae. *Subapical Lobe*. Distinctive; rodlike seta *a* stout, strongly curved in middle, separated from rods *b*, *c* by a wide gap; setae *b*, *c* overlapped at bases with those of setae *d*-*f* on a distinct lobe distad; leaflet g_1 absent or replaced by a weak, short seta distad of g_2, seta *h* weak and rather short; leaflet g_2 slender, bladelike, nearly as long as setae *b*, *c*; setae in group *d*-*f* consist of 2 narrow and fine blades, accompanied by variable number of rather indistinct fine hairlike setae. *Distimere*. Slender, simple, about 0.14 mm in length, distal portion slightly or strongly swollen before tapering to a short, recurved apex; subapical claw very short and small; dorsal and ventral subapical setae rather

strong, subequal, opposite each other. *Phallosome*. Unpigmented, poorly sclerotized; internal process slender, simple, much shorter than external process, the latter with a constricted spiculose apical lobe (or knob) sternad, its upper tergal surface with 15 or fewer weak denticles. *Proctiger*. Apical crown medium-sized, largely consisting of strong, spinelike spicules; 3-6 cercal setae.

PUPA (Fig. 58). Abdomen: 2.3 mm. Paddle: 0.52 mm. Trumpet: 0.45 mm; index 8. Cephalothorax and abdomen usually uniformly yellowish white, with or without indefinite brownish areas. *Trumpet*. Dark brown, relatively short, more or less resembling funnel in shape, meatus uniformly cylindrical, pinna usually flared. Complete chaetotaxy as figured, most setae relatively weak and short. *Cephalothorax*. Seta 5-C weak, as long as or shorter than 7-C, 5, 6 branched; 8, 9-C weak, double. *Metanotum*. Seta 10-C 3, 4 branched; 11-C usually double (1-2); 12-C usually triple (3-4). *Abdomen*. Setae 3-I-III usually double (1-2); 5-IV-VI slightly shorter or longer than segment following; 5-IV usually triple (2-4); 5-V usually double (1-2); 5-VI usually single (1-2); 6-III-VI double or triple; 9-VII usually 4 branched (3-5); 9-VIII apparently placed near caudolateral angle, usually with 8 strongly plumose branches (7-9). *Paddle*. Very pale to almost transparent; moderately broad and long; apical margin rounded and rather indistinct; midrib lightly yellowish and distinct; apical setae 1, 2-P minute, very inconspicuous.

LARVA (Fig. 59). Head: 0.65 mm. Siphon: 0.60 mm; index 5, 6. Saddle: 0.26 mm; siphon/saddle ratio 2, 3. As figured; in general similar to the members of the *Mammilifer* Subgroup with the following diagnostic features. *Head*. Integument pale, cream-colored; seta 1-C dark, slender, spiniform and relatively long, nearly as long as distance between bases of the pair; 4-C very fine, single or double; 5-C usually single, sometimes double; 6-C always single; 7-C weakly plumose, 5, 6 branched. Antennal shaft largely pale, with several strong, spinelike spicules; seta 1-A with about 15 or more pectinate branches; 2, 3-A placed apically. Mental plate with 8 lateral teeth on each side of median tooth. *Thorax*. Spiculation not developed or absent; seta 1-P double; 3-P usually triple (3-4); 4-P usually 6 branched (5-7); 7-P usually triple (2-3); 8-P usually double (1-2), subequal to 7-P; 1-M minute, single, about 0.25 of 3-M; 8, 9-M 7-9 branched; 7, 9-T 8-10 branched. *Abdomen*. Setae 6-I, II usually with 5(4-5) and 4 (3-4) strongly pectinate branches; 7-I single; 6-III-VI usually double, sometimes triple; 1-III-VI weak, short, usually triple (2-4); 1-VII 3, 4 branched. Comb scales narrow, elongate, about 34, all with normal apical fringe of evenly fine spicules. Saddle yellowish to brownish, posterior caudal margin not spiculate; setae 1, 2-X single; ventral brush dark, composed of 6 pairs of setae, all usually inserted within grid, most proximal pair sometimes detached; anal gills long, fusiform, 2-4 times as long as saddle. *Siphon*. Yellowish to dark brown, moderately long, slender, more or less fusiform in shape; pecten teeth 6-8, larger distal teeth narrow, elongate and sharply pointed with 6, 7 fine denticles of graded size; subventral tufts remarkably strong and dense, 7, 8 pairs, 5, 6 branched each, closely spaced, forming a prominent double row; first 3, 4 proximal pairs longest, subequal, 3, 4 times as long as siphonal width at point of attachment, next 3, 4 pairs gradually reduced in length; dorsal and ventral valves of spiracular apparatus poorly differentiated, bearing a strong, hooked seta (9) on its apex; median caudal filament absent.

TYPE-DATA. Lectotype ♂* (marked as type), reared from pitcher plants, SINGAPORE, 1926? D. H. C. Given (BMNH; present selection).

DISTRIBUTION. Known from Singapore, Malaysia and Indonesia. 68 speci-

mens examined: 37♂, 19♀, 12 L; 8 with associated immature skins (1 p, 7 lp).

SINGAPORE. 7♂ (including lectotype), 6♀, 3 L, 4 lp; 3 ♂ (A. R. Barr collection).

MALAYSIA. *Peninsular Malaysia - Selangor:* Pacific Tin, K. Sel; Kg. Tanjong Rabok; *Pahang:* Pekan Rd.; *Kedah:* Sintok F. R.; 26♂, 13♀, 5 L, 1 p, 3 lp.

INDONESIA. *Kalimantan:* Tarakan; 1♂, 4 L.

TAXONOMIC DISCUSSION. *Culex navalis* can be readily separated from all other pitcher plant species except *coerulescens* in the male, including the genitalia, pupa and larva by the characters as indicated in the keys and in the above descriptions. It can be distinguished from *coerulescens* particularly by the development of the modified tufts of the male antenna, the setae of the subapical lobe of the basimere of the male genitalia, the color of antenna of the larva and by a few other features indicated in the keys and descriptions. Caution should be taken in separating the 2 species. Because of the absence of the lower mesepimeral bristle, the adults of *navalis* can be easily mistaken for *bengalensis* and other species of the *Mammilifer* Subgroup. Except for the differences in the detail of the modified tuft of the male antenna and genitalia, a great deal of similarity in the adult morphology is evident between *navalis* and the members of the *minor* complex of the *Mammilifer* Subgroup. This evidence suggests that it was probably directly or indirectly derived from certain forms of the latter subgroup through specialization in the breeding habitat.

BIONOMICS. *Culex navalis* is apparently not uncommon as it has been taken on several occasions at the various localities within its reported range. In Singapore, the larvae were collected from *Nepenthes ampullaria* (Barr and Chellapah 1963: Colless 1965). All collections recently made in Peninsular Malaysia were also reported from this pitcher plant species. They were found in association with the larvae of *coerulescens*, *hewitti* and *acutipalus*. In western Borneo, it was reported to be taken from *Nepenthes bicalcarata* and *rafflezíana* (Brug 1934). All adults apparently came from rearing the larvae or pupae.

47. *CULEX (LOPHOCERAOMYIA) COERULESCENS* EDWARDS
(Fig. 60)

Culex (Lophoceratomyia) coerulescens Edwards 1928: 277 (♂*, ♀); Edwards and Given 1928: 355 (L); Edwards 1932: 197 (taxonomy); Brug and Bonne-Wepster 1947: 186 (distribution).

Culex (Lophoceraomyia) coerulescens Edwards, Mattingly 1949: 226 (L); Stone, Knight and Starcke 1959: 232 (catalog); Colless 1965: 305 (♂*, ♀, L).

FEMALE. Exceedingly similar to *navalis* from which it can not be distinguished with certainty, differing slightly in having finer and largely pale decumbent scales in the center of vertex. *Cibarial Armature*. Apparently indistinguishable from *navalis*.

MALE (Fig. 60). Essentially similar to *navalis*, differing particularly in the following details. *Palpus*. Length usually equal to proboscis. *Antenna*. Pedicel apparently with weaker spiculose prominence on its inner dorsal surface; modified tuft of F-5 reduced, rather inconspicuous, consists of only a few short fine hairlike setae among several normal long setae; modified tufts of F-6, 7 reduced or more weakly developed; F-8 with a smaller tuft of 4, 5 fused setae which are gently curved, or not strongly hooked; F-9 with 4 rela-

tively weak bristlelike setae; F-9-11 with or without 1-3 short setae distad of normal whorls.

MALE GENITALIA (Fig. 60). Exceedingly similar to *navalis*, differing from it particularly in the following features. *Basimere*. Inner tergal surface always with 1 strong submarginal seta; marginal setae relatively stronger or more conspicuous. *Subapical Lobe*. Rod *a* rather slender and straight, more or less overlapped with rods *b*, *c* in distal portion; setae *d*-*f* stronger, longer, more or less flattened, bladelike, 3, 4 in number; hairlike setae associated with setae *d*-*f* stronger, very distinct and apparently more numerous. *Distimere*. Slender, distally tapering to a blunt, gently recurved point, apical portion not swollen distad of median curvature; dorsal subapical seta distad of ventral. *Phallosome*. External process of lateral plate apparently without distinct apical spiculose lobe (or knob) sternad. *Proctiger*. Cercal setae 3.

PUPA. As figured and described for *navalis* (Fig. 58), differing from it in the following characters. *Metanotum*. Seta 12-C double. *Abdomen*. Seta 9-VII usually 5, 6 branched (4-6). *Paddle*. Relatively smaller and shorter, about 0.48 mm in length.

LARVA (Fig. 60). Extremely similar to *navalis*, differing from it in the following characters. *Head*. Seta 5-C always double. Antennal shaft entirely dark brown; spicules strong, fewer, more or less restricted to lateral surface below insertion of seta 1-A. *Thorax*. Seta 1-P always single; 7-P double; 1-M longer, almost as long as 3-M. *Abdomen*. Seta 7-I double, rarely single. Saddle dark brown, same color as antenna; seta 1-X weaker, double. *Siphon*. Dark brown, same color as antenna and saddle; subventral tufts relatively stronger and more pigmented.

TYPE-DATA. Holotype ♂*, Kuching, *Sarawak*, Borneo, [MALAYSIA], 1914, J. C. Moulton (BMNH).

DISTRIBUTION. Known only from Malaysia (Peninsular Malaysia and Borneo) and Singapore. 21 specimens examined: 10♂, 8♀, 3 L; 5 with associated lp skins.

MALAYSIA. *Peninsular Malaysia - Selangor:* Pacific Tin, K. Sel.; Kg. Tanjong Rabok; *Johore:* Kota Tinggi; 7♂, 6♀, 1 L, 3 lp. *Malaysia - Sarawak:* Kuching; 3♂.

SINGAPORE. 2♀, 2 L, 2 lp.

TAXONOMIC DISCUSSION. *Culex coerulescens* is extremely similar to *navalis* in all stages and evidently falls into a complex with the latter species. It can be differentiated from *navalis* in the male by the details of the modified tufts of the antenna, as described above; in the male genitalia by the details of the setae of the subapical lobe and the shape of the distimere; in the pupa by the reduction in size and length of the paddle and in the larva by the dark antenna; the single seta 1-P; the double seta 7-P and the double seta 7-I. Both species overlap in distribution and breeding site, but there is apparently no indication of intergradation in their specific diagnostic features among the material which I have examined.

BIONOMICS. As in *navalis*, *coerulescens* has also been found to utilize *Nepenthes ampullaria* and other pitcher plant species as breeding sites. It appears to be rare and less common than *navalis*.

hewitti complex

48. *CULEX (LOPHOCERAOMYIA) HEWITTI* (EDWARDS)
(Figs. 61, 62)

Lophoceratomyia hewitti Edwards 1914a: 80 (♂, ♀).
Culex (Lophoceratomyia) hewitti (Edwards), Edwards 1928: 277 (♂*); Edwards and Given 1928: 355 (L*); Brug and Edwards 1931: 261 (distribution); Brug and Bonne-Wepster 1947: 186 (distribution).
Culex (Lophoceraomyia) hewitti (Edwards), Stone, Knight and Starcke 1959: 233 (catalog); Colless 1965: 303 (♂*, ♀, L).

FEMALE. Wing: 2.5 mm. Forefemur: 1.3 mm. Proboscis: 1.7 mm. Small or minute species; in general extremely similar to *navalis* and *coerulescens*, differing in smaller size and in the following features. *Head*. Decumbent scales on ocular line of vertex broader, extending to posterolateral areas; narrow linear decumbent scales restricted to dorsal midline in center; erect scales finer, usually entirely blackish, sometimes distally pale yellowish; palpus more slender, segmentation not clearly marked. *Cibarial Armature* (Fig. 61). Cibarial bar with 18-20 short teeth, 4 median teeth narrow, fine, apically pointed; lateral teeth very coarse, widely spaced, dark at bases, pale distally, with apices abruptly pointed, truncate or blunt.

MALE (Fig. 61). As in female except for smaller size. *Palpus*. Very slender, distinctly shorter than proboscis by about the length of segment 5: segments 4, 5 markedly reduced in length. *Proboscis*. Very slender and thin. *Antenna*. Flagellar whorls weakly to strongly plumose, normal long setae rather few or sparse; modified tufts of scales or setae poorly developed; F-5 apparently without any conspicuous modified setae or scales, sometimes with 2, 3 undifferentiated, shortened setae among normal long setae; F-6 with a characteristic tuft of 2-4 dark, narrow, subapically swollen budlike scales which are equally long and apically drawn out into fine points; F-7 with a markedly reduced comb-shaped tuft of 3, 4 short, subapically swollen setae and a thick dark tuft of fused, subapically twisted setae; F-8 with relatively small, gently hooked tuft of 5, 6 fused setae; F-9 with or without 4 dark, weak bristlelike setae; F-9-11 usually with 1 short seta distad of whorls.

MALE GENITALIA (Fig. 61). Small or minute. *Segment IX*. Tergal lobe poorly developed, bearing 2, 3 short fine setae; sternum with a transverse row of 5 strong setae caudad. *Basimere*. Broad, conical, about 0.17 mm in length, sometimes shorter; inner tergal surface without differentiated submarginal setae; lateral tergal surface with numerous strong setae and bristles. *Subapical Lobe*. Rodlike setae *a-c* largely overlapping, *a*, *b* stout, subequal, *c* very slender, all with hooked apices; leaflet g_1 replaced by a short, hairlike seta, subequal to seta *h;* setae *d-f* narrow, bladelike, 5, 6 in number; leaflet g_2 more or less similar to setae in group *d-f*, but broader and longer. *Distimere*. Rather thick, as long as basimere, with strongly modified recurved apex; dorsal subapical surface irregular, with a few toothlike spicules; subapical claw slender and relatively long, dorsal and ventral subapical setae present, distinct, placed opposite each other. *Phallosome*. Poorly sclerotized; internal process short, simple, spinelike; external process distally tapered in lateral aspect, with several minute denticles or spicules largely restricted to its apex, apical lobe (or knob) not differentiated. *Proctiger*. Essentially similar to other species in the *Mammilifer* Group; apical crown

medium-sized; composed of several strong and weak spinelike spicules; cercal setae 3-5.

PUPA (Fig. 61). Abdomen: 2.1 mm. Paddle: 0.36 mm. Trumpet: 0.40 mm; index about 8. Similar to *navalis* in the shape and length of trumpet and detailed chaetotaxy, differing in darker pigmentation and in the following characters. *Cephalothorax*. Seta 8-C usually triple (2-4); 9-C usually double or triple (2-4). *Abdomen*. Seta 3-II, III single; 3-III strong, slightly longer than segment following; 5-IV-VI remarkably strong and long, all single; 5-V, VI at least 2 times as long as segment following; 9-VIII large, almost as long as paddle length, usually 8 branched (7-9). *Paddle*. Markedly reduced in width and length; setae 1, 2-P minute, rather inconspicuous.

LARVA (Fig. 62). Head: 0.52 mm. Siphon: 1.0 mm; index 9-10. Saddle: 0.26 mm; siphon/saddle ratio 4. In general similar to *navalis* and *coerulescens*, differing as follows. *Head*. Integument pale yellowish; seta 1-C long, slender, spiniform and pale; 4-C weak, 3, 4 branched, situated near dorsal midline; 5-C weak, as long as 7-C, situated at same level as 6-C,mesad, usually with 6 pectinate branches (5-9); 6-C long, single; 7-C 7, 8 branched; 8-C long, single (1-2). Antenna entirely pale, about 0.75 of head length; spicules numerous and fine; seta 1-A with 9-11 short plumose branches; 2, 3-A apical or slightly subapical. *Thorax*. Seta 1-P single and long; 2, 3-P weak, subequal and single; 4-P double; 7, 8-P double; 8, 9-M 5 branched; 7, 9-T 5-7 branched. *Abdomen*. Setae 6-I, II usually triple (3-5); 7-I double; 6-III-VI double; 1-III-VI weak, double or triple; 1-VII single, strongly pectinate. Comb scales numerous, minute, about 50. Saddle pale yellowish. *Siphon*. Slender, distally tapering, same color as head capsule and saddle; pecten teeth 5-9; larger distal teeth narrow, elongate, with 12-15 fine, undifferentiated denticles; subventral tufts strong, 6, 7 pairs, each usually 5 branched (3-6), forming a prominent double row between 0.25-0.75 of total siphon length; 5, 6 proximal pairs long, subequal, 4, 5 times as long as siphonal width at point of attachment; 1, 2 distal pairs markedly or gradually reduced in length.

TYPE-DATA. Lectotype ♂* (one of 2 males in the type-series described by Edwards 1914a: 80), Matang, *Sarawak*, N. Borneo [MALAYSIA], July 1908, J. Hewitt (BMNH; present selection).

DISTRIBUTION. Known only from Malaysia, Singapore and Sumatra, Indonesia. 88 specimens examined: 46♂, 28♀, 14 L; 29 with associated immature skins (14 p, 15 lp).

MALAYSIA. *Peninsular Malaysia - Selangor:* Pacific Tin, Butang; Kg. Tanjong Rabok; *Pahang:* Pekan Rd.; *Johore:* Kota Tinggi; 33♂ 21♀, 6 L, 12 p, 9 lp. *Malaysia - Sarawak:* Matang (type-locality); Mt. Dulit; 2♂.

SINGAPORE. Lornil Rd.; Pearce Reservoi Nee Soon Rifle Range; 2♂, 5♀, 3 L, 2 p, 3 lp; unspecified locality; 4♂ (A. R. Barr collection).

INDONESIA. *Sumatra:* Dermajoe, Air Prioekan; 5♂, 2♀, 5 L, 3 lp.

TAXONOMIC DISCUSSION. *Culex hewitti* apparently falls into a distinct complex of the *Brevipalpus* Subgroup. It appears to resemble *navalis* and *coerulescens* more than other known pitcher plant species. It can be readily recognized in the adults by the relatively small or rather minute size, in the male by the peculiar modified scale tuft of antennal flagellomere 6 and the reduction of the modified tufts of antennal flagellomeres 7-9; in the genitalia by the details of the setae of the subapical lobe, the modified recurved apex of the distimere and the shape of the external process of the phallosome; in the pupa by the elongate, funnel-shaped trumpet; the remarkably strong, single setae 5-IV-VI of the abdomen and the reduction in size and length of the paddle and in the larva by the branching and position of setae 4, 5, 6 and 8-C; the branching

of setae 1, 3, 4, 7 and 8-P and the features of the siphon.

The male antenna and genitalia of the type of *hewitti* originally designated by Edwards were lost. I have, however, examined 2 other males in the original type-series of the author and here selected one of these as a lectotype.

BIONOMICS. *Culex hewitti* is apparently as common as *navalis* and has usually been found in association with the latter in the same species of pitcher plant *(Nepenthes ampullaria)*. In Singapore, the immatures have also been found with specimens of *curtipalpis* in *Nepenthes gracilis* (Barr and Chellapah 1963).

jenseni complex

49. *CULEX (LOPHOCERAOMYIA) JENSENI* (DE MEIJERE)
(Figs. 63, 64)

Cyathomyia jenseni de Meijere 1910: 922 (♂*, ♀, P*, L*).
Culex (Lophoceratomyia) jenseni (de Meijere), Edwards 1928: 279 (♂*); Edwards and Given 1928: 356 (L); Brug and Edwards 1931: 261 (distribution); Brug and Bonne-Wepster 1947: 186 (distribution).
Culex (Lophoceraomyia) jenseni (de Meijere), Mattingly 1949: 226 (L); Stone, Knight and Starcke 1959: 234 (catalog); Colless 1965: 303 (♂*, ♀, L).

FEMALE. Wing: 3.5 mm. Forefemur: 1.8 mm. Proboscis: 2.1 mm. In general exceedingly similar to the *navalis* complex, differing slightly in larger size and in the following. *Head*. Narrow linear decumbent scales of vertex relatively dense, more numerous and entirely pale whitish; erect scales coarser, pale golden or yellowish in center and on anterior margin, dark brownish on posterolateral areas; lateral patch of broad scales whitish, very distinct. *Cibarial Armature* (Fig. 63). Essentially similar to *mammilifer, minor* and most members of the *Mammilifer* Subgroup; cibarial bar with 30 or more narrow elongate teeth which are subequal in size and length, closely spaced and distally tapering into sharp points. *Thorax*. Mesonotal scales relatively dense, vestiture smooth. Pleuron with or without a few pale translucent scales on upper corner and posterior border of *stp*.

MALE (Fig. 63). In general as in female, with the following distinctive features. *Antenna*. Spiculose prominence of pedicel moderately to strongly developed; flagellar whorls densely long plumose; F-5 with a distinct tuft of 2, 3 long, narrow golden acute scales as long as or slightly longer than the next 4 flagellomeres; modified tufts of F-6, 7 weakly developed; F-6 with 2 short, fine hairlike setae and 1 dark, weakly curled flattened seta; F-7 with a lateral tuft of 5 dark, weakly curled setae and a small ventral tuft of 3 fused, subapical, twisted or kinky setae. F-8 with a smoothly curved or typically J-hooked tuft of 6, 7 fused setae; F-9 with 3 long poorly differentiated bristlelike setae; F-9-11 without any short setae distad of normal whorls.

MALE GENITALIA (Fig. 63). Very similar to *navalis* and *coerulescens*, differing particularly in the following features. *Segment IX*. Tergal lobe with 3, 4 longer hairlike setae; sternum with a transverse row of 6 strong setae caudad. *Basimere*. Relatively larger, about 0.22 mm in length; submarginal setae absent. *Subapical Lobe*. Broad; rodlike setae *a-c* straight or smoothly curved and largely overlapping; rod *a* strong with abruptly pointed apex, *b, c* more slender and longer, with hooked apices; seta *h* very strong and long, placed close to the base of rod *a;* leaflet g_1 absent or represented by a short weak, hairlike seta; setae *d-f* consist of 3 short narrow blades and 1 hairlike seta; leaflet g_2 in form of a long stout blade. *Distimere*. More slender,

typically sickle-shaped with distal portion tapered to a slender, recurved apex; ventral subapical seta stronger and more distinct than dorsal; subapical claw short, apically broad and rounded. *Phallosome*. External process of lateral plate tapered to a round, apical spiculose lobe, upper tergal surface without any distinct teeth or denticles; internal process short, slender, about 0.5 of external process in length.

PUPA (Fig. 63). Abdomen: 2.5 mm. Paddle: 0.60 mm. Trumpet: 0.3-0.4 mm; index 3-4. Rather similar to *brevipalpus* complex, with the following diagnostic features. More or less uniformly yellowish with light brownish tinge on cephalothorax and metanotum. *Trumpet*. Brownish, short, stout, sausage-like, apex slightly projecting beyond margin of middorsal ridge in flat preparation. *Cephalothorax*. Seta 1-C single; 5-C very strong and long, single; 7-9-C single, subequal. *Metanotum*. Seta 10-12-C single; 12-C sometimes double. *Abdomen*. Seta 1-II weakly plumose, 5, 6 branched; 3-I-III single; 5-IV-VI single, as long as or slightly shorter than segment following; 6-III-VI single; 9-VII weak, double or triple; 9-VIII 5-7 branched, subequal to or slightly longer than 9-VII. *Paddle*. Broad and pale; outer margin distinct, midrib lightly pigmented; setae 1, 2-P indistinct or not developed.

LARVA (Fig. 64). Head: 0.78 mm. Siphon: 0.65 mm; index 3. Saddle: 0.38 mm; siphon/saddle ratio 1.7-1.8. Rather similar to *brevipalpus* complex with the following diagnostic features. *Head*. Yellowish or pale cream-colored; seta 1-C dark, long, stout, spiniform; 5-7-C dark, subequally long; 5, 6-C usually triple (2-5); 7-C 8 branched. Antenna straight, proximally swollen and entirely pale, or same color as head capsule; spicules minute, sparse and rather inconspicuous; seta 1-A short, weak, 3-6 branched, situated at 0.75 of the length from base; 2, 3-A dark, strong and long. Mental plate narrow, with 8, 9 equally small lateral teeth on each side of a large median tooth. *Thorax*. Setae 1, 2-P single; 3-P double; 4-P 3, 4 branched; 5, 6-P single or double, sometimes triple; 7-P double or triple; 8-P double; 14-P double; 5-M 2-7 branched. *Abdomen*. Setae 6-I, II dark, 3, 4 branched; 7-I double; 6-III-VI double; all other setae weak and short. Comb scales 24-30, aggregating in 2, 3 rows; apical fringe of posterior scales more or less pointed or terminated into a strong median spine, latter sometimes not differentiated. Saddle same color as head capsule; spiculation weakly developed or absent; seta 2-X single or double; ventral brush dark, with 6 pairs of triple or more branched setae. *Siphon*. Short, thick, distally slightly tapered, sometimes more or less cylindrical; pigmentation pale, concolorous with head capsule and saddle; pecten teeth 4-8, widely spaced, with fine barb of several minute denticles; siphonal tufts 8-10 pairs, first 5, 6 subventral pairs very dark, strong, 4-6 branched each, 3, 4 times as long as siphonal width at point of attachment; 2-4 weaker pairs strongly reduced, 3, 4 branched; more proximal 1-3 pairs placed dorsolaterally distad of pecten from 0.4-0.7 of siphon, most distal pair subapical, in line with the strong subventral pairs.

TYPE-DATA. Lectotype ♂ (No. 32) with attached genitalia mount, Tjibodas, Bogor (Buitenzorg), Java [INDONESIA], in *Nepenthes* pitcher, 1909, Dr. Jensen (Zoological Museum, Amsterdam University; selection of Bram 1967b: 328).

DISTRIBUTION. Known only from Malaysia (Sabah), Singapore and Indonesia (Sumatra and Java). 72 specimens examined: 15♂, 3♀, 54 L, 8 with associated lp skins.

MALAYSIA. *Sabah:* Mt. Kinabalu; 54 L.

SINGAPORE. 1♂.

INDONESIA. *Sumatra:* Batang, Palupuk; 1♂; *Java:* Bogor (Buitenzorg);

Tjibodas (Botanical Garden); Mt. Salak; 13♂, 3♀, 8 lp.

TAXONOMIC DISCUSSION. *Culex jenseni* is an interesting pitcher plant form which exhibits a bizarre combination of characters of the *Mammilifer* Subgroup in the female cibarial armature, the *navalis* complex in the male antenna and genitalia and the *brevipalpus* complex in the relatively short male palpus, the chaetotaxy and general features of the pupa and larva. It can be readily recognized and separated from other pitcher plant species in all stages by the characters as given in the above diagnosis and as illustrated. Because of several distinctive features, *jenseni* apparently falls into a distinct complex of the *Brevipalpus* Subgroup.

Several topotypic males of *jenseni* from Java and a few other males from Sumatra and Singapore which I have thoroughly re-examined in the collections of the Instituut voor Tropische Hygiene, Amsterdam and the BMNH agree well with the previous descriptions by Edwards (1928: 279) and Colless (1965: 303). I have not seen the larvae from Singapore described by Edwards and Given (1928: 356), but judging from the description of these authors, they apparently conform to the topotypic specimens described above. The numerous whole larvae recently collected from Sabah, Malaysia, which I have tentatively identified with this species are, however, variable and appear to be locally differentiated into 2 forms. One of these almost corresponds with the typical form in the detailed chaetotaxy but differs from it in having posterior comb scales terminating into a stout median apical spine, setae 5, 6-P usually double or triple and in the presence of 2 or 3 additional pairs of weak dorsolateral tufts from basal 0.40-0.75 of the siphon. The other differs from the typical form rather constantly in having setae 5 and 6-C and setae 6-III-VI single. It is probable that 2 or more forms are involved and that at least one of these may be recognized as distinct. However, in the absence of correlated male specimens, it seems best to consider this larval material only as forms of *jenseni* or the *jenseni* complex for the present.

BIONOMICS. *Culex jenseni* is apparently restricted to high elevations in mountainous areas where it is fairly common and has been found on several occasions. At the type-locality on Tjobidas Mountain and Bogor, Java, the larvae were collected from unknown pitcher plant species at an elevation ranging from 1,500-1,600 m. At Mt. Kinabalu, Sabah, the larvae were taken from *Nepenthes villosa* at an elevation of about 2,500 m (8,200 ft.). In Singapore, the larvae were collected from pitcher plants without further particulars (Edwards and Given 1928: 356).

brevipalpus complex

50. *CULEX (LOPHOCERAOMYIA) BREVIPALPUS* (THEOBALD)
(Figs. 65, 66)

Lophoceratomyia brevipalpus Theobald 1905b: 96 (♂); Theobald 1907: 477 (♂); Leicester 1908: 129 (♂); Stone 1957: 172 (nomenclature).

Culex (Lophoceratomyia) eminentia (Leicester), in part, Edwards 1928: 278 (♂*); Edwards and Given 1928: 355 (L*).

Culex (Lophoceraomyia) brevipalpus (Theobald), Colless 1965: 301 (♂*, ♀, L).

FEMALE. Wing: 2.8 mm. Forefemur: 1.5 mm. Proboscis: 1.8 mm. Medium or small size, in general conforming to the *Brevipalpus* Subgroup with the following distinctive features. *Head*. Decumbent scales on dorsum of ver-

tex narrow, linear and entirely dark or partially pale whitish along upper eye border, dark brownish in the center; erect scales coarse, usually predominantly pale bronzy or golden, sometimes entirely dark brown; lateral patch of broad scales grayish to blackish, not distinct. *Cibarial Armature* (Fig. 65). Cibarial bar narrow, with 15-25 teeth; 2, 3 median teeth narrow, elongate, distally tapering into sharp points, lateral teeth coarser, shorter, more widely spaced with blunt, abruptly pointed or truncate apices. *Thorax*. Mesonotal integument deep chestnut brown; scales narrow, fine and blackish. *Apn* with a few to several dark broad scales which sometimes form a distinct patch. Pleural integument paler than or as dark as mesonotum; *ppl* without any scales; upper corner and posterior border of *stp* usually with some scattered pale scales; lower *mep* bristle absent. *Legs* and *Wing*. As described for the *Mammilifer* Group, apparently without any distinctive features. *Abdomen*. Terga and sterna dark scaled; terga II-IV usually slightly pale beige on lateral margin.

MALE (Fig. 65). In general similar to female with the following distinctive characters. *Palpus*. About 0.5 of the length of proboscis, segments 3, 4 without any apical setae or bristles, segment 5 with 1 short apical spinelike seta. *Proboscis*. Rather slender and thin in basal 0.5, apical 0.5 gradually thickened. *Antenna*. Spiculose prominence of pedicel well developed, distinct; flagellar whorls moderately to strongly plumose; modified tufts of scales and setae present on F-5 to F-9; F-5 with a distinct tuft of 5 narrow, acute scales; dorsalmost scales usually dark, as long as next 3 flagellomeres, the remaining scales yellowish, golden or brownish, gradually increased in length, sometimes all scales pale yellowish; F-6 with a crumpled tuft of 5 dark weakly curled setae; F-7 with a lateral comb-shaped tuft of 10 distally kinked setae and a ventral tuft of 4 subapically twisted fused setae; F-8 with a slender and weak J-hooked tuft of 5, 6 fused setae; F-9 with 2-4 long and strong bristlelike setae.

MALE GENITALIA (Fig. 65). *Segment IX*. Tergal lobe poorly developed, bearing 3, 4 tiny setae; sternum with 4-10 strong setae in a transverse row caudad. *Basimere*. Rather broad, more or less rectangular or somewhat square in shape; its length about 0.22 mm, maximal width about 0.75 of the length; inner and lateral tergal surface practically bare or with only a small number of short, minute setae; submarginal setae absent; strong setae and bristles restricted to outer tergal surface. *Subapical Lobe*. Details as figured; very broad; with several strong, flattened accessory bladelike setae in group *d-f* densely packed at bases of usual rodlike setae *a-c* and leaflet g_2; rod *a* stout, short, not clearly differentiated from other bladelike setae; rods *b, c* distinct, stout, subequally long and apically hooked; leaflet g_1 absent; seta *h* very long, flattened, rodlike, as long as or longer than rods *b, c;* setae in group *d-f* all strong, bladelike; leaflet g_2 strong, long, markedly flattened and subapically bent, somewhat resembling a boot in shape. *Distimere*. Sickle-shaped, with characteristic modified truncate apex; ventral subapical seta strong, spiniform; dorsal subapical seta weak, short, setiform or sometimes spiniform; subapical claw short, flattened and apically blunt. *Phallosome*. External process slender, with a distinct apical spiculose lobe (or knob) sternad and variable number of weak denticles at base of lobe, upper tergal surface with or without a few weak denticles at some distance below base of apical lobe; internal process shorter than external process. *Proctiger*. As described for the *Mammilifer* Group; cercal setae 2.

PUPA (Fig. 65). Abdomen: 2.5 mm. Paddle: 0.65 mm. Trumpet: 0.3 mm; index 3, 4. Cephalothorax and abdomen brownish yellow, sometimes

lighter or yellowish white. *Trumpet*. Dark brown, short, stout, sausage-like. Complete chaetotaxy as figured, rather similar to *jenseni*, differing as follows. *Cephalothorax*. Seta 5-C single, strong and long, about 3 times as long as trumpet; 8-C strong, 3 times as long as 9-C. *Metanotum*. Setae 10-12-C always single. *Abdomen*. Seta 1-II weaker, 3, 4 branched; 6-I, II very strong and long; 5-IV, V strong, 1.5 times as long as segment following; 9-VII, VIII single and strong; 9-VIII almost as long as paddle. *Paddle*. Midrib strong and dark pigmented.

LARVA (Fig. 66). Head: 0.67 mm. Siphon: 0.90 mm; index 4.7. Saddle: 0.32 mm; siphon/saddle ratio 3. In general very similar to *jenseni*. *Head*. Seta 1-C pale, distally filamentous; 4-C close together near dorsal midline; 5-7-C relatively short, flattened, strongly plumose, situated more cephalad; 5-C 2-4 branched; 6-C single; 7-C 4-6 branched. Antennal shaft practically bare or with a few to several minute, inconspicuous spicules; setae 2, 3-A weak short and pale. Mental plate very dark and broad, with 2, 3 large and 4, 5 small lateral teeth on each side of median tooth. Mouth brush strong, rather coarse and short. *Thorax*. Setae 3, 5, 6-P single; 4-P double or triple; 7, 8-P usually double (1-3); 14-P single or double; 5-M 4, 5 branched. *Abdomen*. Seta 6-I 4-6 branched; 6-II triple; 7-I usually triple (3-5); 7-II strong, subequal to 7-I, usually triple (2-5); 6-III-VI double or triple; setae 1, 13-III-VI and 1, 4, 7, 10, 12 and 13-VII single and strongly flattened. Comb scales 20-30, all with apically rounded fringe of evenly fine spicules. Setae 1, 2, 4, 5-VIII single. Saddle seta 2-X with 1 short and 1 long branch. *Siphon*. Pecten teeth 2-4; subventral tufts at least 7 pairs, sometimes 8, 9, all in a prominent double row on lateral ventral surface; 6, 7 strong proximal pairs 4-6 branched, 3, 4 times as long as siphonal width at point of attachment.

TYPE-DATA. Holotype ♂ with slide of genitalia, SINGAPORE, 1902, Hungarian National Museum, Budapest (HNM).

DISTRIBUTION. Known only from Malaysia and Singapore. 62 specimens examined: 26♂, 20♀, 16 L, 21 with associated lp skins.

MALAYSIA. *Peninsular Malaysia - Johore:* Kota Tinggi; *Pahang:* Pekan Rd.; Trengganu: Kemaman; 18♂, 20♀, 12 L, 18 lp. *Malaysia - Sabah:* Jesselton; 1♂.

SINGAPORE. Kg. Chantek Bahru; Swiss Club; other unspecified localities; 7♂, 4 L, 3 lp.

TAXONOMIC DISCUSSION. *Culex brevipalpus* and the next 3 species, *lucaris*, *eminentia* and *acutipalus* of the *brevipalpus* complex, are very similar, forming a compact monophyletic group which exhibits its strongest affinity with the *jenseni* complex in pupal and larval morphology. As noted by Colless (1965), morphological differences among the members of this complex are exceedingly slight, but each is apparently distinct and can be differentiated from the others by the subtle details of the modified tufts of the male antenna, the setae of the subapical lobe of the genitalia, and the usual features of larval and pupal chaetotaxy as indicated in the keys, figures and descriptions. The males of *brevipalpus* differ from *eminentia* and *acutipalus* in the modified tufts of antennal flagellomeres 5, 8 and 9, but are extremely similar to those of *lucaris*. It can be separated from the latter by the stronger and longer seta *h* and the absence of numerous short hairlike setae at the base of seta g_2 of the subapical lobe of the genitalia. The pupae are indistinguishable from *acutipalus*, but can be separated from *lucaris* and *eminentia* by the stronger and longer setae 5 and 8-C, 5-IV-VI and 9-VII-VIII. The larvae differ from *eminentia* in having seta 4-C more closely spaced near the dorsal midline, stronger setae 1-4-P and by the usually double setae 7 and 8-P; from *lucaris* and *acutipalus* in

having stronger seta 7-II which is of the same magnitude as setae 6-I-II or 7-I.

BIONOMICS. The larvae of *brevipalpus* have been collected either from *Nepenthes ampullaria* or *gracilis* in open sunlight or under partial shade of secondary tropical forest at an elevation ranging from sea level to about 30 m. In Singapore, *brevipalpus* has been reported to be more common than *eminentia* and *acutipalus* (Colless 1965: 301). Of 6 collections recently made in Peninsular Malaysia, the larvae and reared adults were once found in association with the specimens of *eminentia*. The strong filaments of the mouth brush and the heavy teeth of the maxilla, mandible and mental plate of the larvae suggest that it probably feeds by chewing on dead insects trapped in the pitcher plants.

51. *CULEX (LOPHOCERAOMYIA) LUCARIS* COLLESS
(Fig. 67)

Culex (Lophoceraomyia) lucaris Colless 1965: 299 (♂*); Bram 1967a: 79 (♂*).

FEMALE. Exceedingly similar to *brevipalpus* from which it can not be distinguished with certainty, differing slightly in the following: *Thorax*. *Ppl* usually with a few pale scales on anterior surface; upper corner and posterior border of *stp* usually with more numerous pale translucent scales aggregated into distinct patches.

MALE (Fig. 67). As described and figured for *brevipalpus*, differing from it particularly in the following features. *Palpus*. Relatively longer, its length usually 0.60-0.75 of proboscis. *Antenna*. F-8 with a smoothly curved J-hooked tuft of fused setae; F-9 with a stronger tuft of 4 bristlelike setae.

MALE GENITALIA (Fig. 67). Exceedingly similar to *brevipalpus*, differing from it in the following features. *Subapical Lobe*. Seta *h* shorter and weaker, bristlelike, as long as or shorter than rodlike setae *b, c;* base of seta g_2 prominent, with numerous conspicuous hairlike setae; setae in group *d-f* shorter and narrower.

PUPA. As figured and described for *brevipalpus* (Fig. 65), differing from it in having most setae considerably shorter and weaker and in the following. *Cephalothorax*. Seta 5-C weaker and shorter, about 1.25 of trumpet length. *Abdomen*. Setae 5-IV-VI weaker, shorter than or as long as segment following; setae 6-III-VI weaker, usually double or triple, sometimes single; 9-VII much weaker, usually double or triple, sometimes single or 4 branched; 9-VIII shorter, about 0.5 of paddle length. *Paddle*. Midrib weak and pale.

LARVA. As figured and described for *brevipalpus*, differing from it in the following features. *Head*. Seta 4-C more widely spaced. *Thorax*. Seta 4-P usually double (2-3); 7-P usually single (1-2); 8-P single or double. *Abdomen*. Seta 7-II very weak and pale, similar to 7-III-VI, 5, 6 branched; 6-III-VI double or triple. *Siphon*. Subventral tufts usually 7 pairs, sometimes 8 or 9.

TYPE-DATA. Holotype ♂ with slide of antenna (CH 70) and genitalia (CT 663), Ulu Pandan, SINGAPORE, 7 July 1957, D. H. Colless (ANIC).

DISTRIBUTION. Known only from Thailand, Peninsular Malaysia and Singapore. 44 specimens examined: 23♂, 16♀, 5 L; 21 with associated immature skins (3 p, 18 lp).

THAILAND. *Ranong:* Hard Sam Pan; Ban Phong Rang; 3♂, 2 L, 1 p, 1 lp.

MALAYSIA. *Peninsular Malaysia - Selangor:* Ulu Klang; 2♀, 1 p.

SINGAPORE. Unspecified locality; Ulu Pandan; Pulau Blakang Mati; 20♂,

14♀, 3 L, 1 p, 17 lp.

TAXONOMIC DISCUSSION. As discussed under *brevipalpus*, morphological differences between *lucaris* and the other 3 members of the *brevipalpus* complex are only slight and caution should be taken in separating them. The most distinctive features of the males of *lucaris* are: the relatively long palpus which is slightly more than 0.5 of the proboscis length; the shape of the modified tuft of antennal flagellomere 8 which is smoothly curved or of a typical J-shape rather than sigmoid and the presence of numerous hairlike setae at the base of the boot-shaped seta g_2 of the subapical lobe of the genitalia. In the immatures, the pupa is indistinguishable from *eminentia* but can be differentiated from *brevipalpus* and *acutipalus* by the weaker and shorter setae of the cephalothorax and abdomen and the usually double or triple setae 6-III-VI and 9-VII. The larva is separated from *brevipalpus* and *eminentia* by the considerably weaker and shorter seta 7-II, from *acutipalus* by the more widely spaced seta 4-C and by a few other usual features as described under the latter species.

BIONOMICS. As in *brevipalpus*, *lucaris* usually occurs in the open secondary tropical forest at a low elevation ranging from sea level to about 60 m. In Singapore, the larvae have been collected from *Nepenthes gracilis*, *rafflesiana* and other unidentified pitcher plant species along the coast as well as towards the inland hills. Larvae from a single collection in Peninsular Malaysia were found in *Nepenthes gracilis* in association with specimens of *eminentia*. In Thailand, all collections were made from pitcher plant species without further particulars. Most of the adults came from rearing larvae or pupae. In Singapore, Colless (1965: 299) noted that the adults were taken while resting by day in an isolated patch of rather open forest.

52. *CULEX (LOPHOCERAOMYIA) EMINENTIA* (LEICESTER)

(Fig. 67)

Lophoceratomyia eminentia Leicester 1908: 131 (♂).

Culex (Lophoceratomyia) eminentia (Leicester), in part, Edwards 1917: 227 (♂, key); Edwards 1928: 278 (♂*); Edwards and Given 1928: 355 (L*); Edwards 1932: 198 (taxonomy); Brug and Bonne-Wepster 1947: 186 (distribution).

Culex (Lophoceraomyia) eminentia (Leicester), Stone, Knight and Starcke 1959: 233 (catalog, in part); Colless 1965: 298 (♂*, ♀, L).

FEMALE. As described for *brevipalpus* and *lucaris* from which it is indistinguishable.

MALE (Fig. 67). In general as in female, differing from *brevipalpus* and *lucaris* particularly in the following features. *Palpus*. Longer, about 0.75-0.90 of proboscis length. *Antenna*. Modified tuft of F-5 larger, very conspicuous, composed of 6-10 bright yellow or golden, broad lanceolate scales which are as long as the combined length of next 4 flagellomeres; F-6 with a stronger tuft of 9-10 curled setae; F-8 with a sigmoid-hooked tuft of 6, 7 fused setae; modified tuft of F-9 large, prominent, consisting of 10-12 long, strong, flattened setae which are more or less fused proximally.

MALE GENITALIA (Fig. 67). Essentially similar to *brevipalpus* and *lucaris*, differing particularly in the following features. *Subapical Lobe.* Seta *h* absent or replaced by a weak short, inconspicuous seta; base of boot-shaped seta g_2 in distal portion without distinct long, hairlike setae; bladelike setae *d-f* and other accessory flattened setae at bases of rods *a-c* apparently fewer

and stronger.

PUPA. Extremely similar to *lucaris* in having most setae relatively weak and short and in diagnostic chaetotaxy as described under the latter species.

LARVA. As described and figured for *brevipalpus*, differing from it and from other members of the *brevipalpus* complex in the following combinations. *Head*. Seta 4-C more widely spaced. *Thorax*. Setae 1-8-P relatively weak and short, 7, 8-P double or triple. *Abdomen*. Seta 7-II double, as strong as or subequal to 6-I, II and 7-I. *Siphon*. Subventral tufts 7, 8 pairs.

TYPE-DATA. Lectotype ♂*, Kuala Lumpur, (Selangor), Malaya [MALAYSIA], Jungle patch, 5th mile, Gombak Rd., 5 December 1903, G. F. Leicester (BMNH; selection of Colless 1965: 298).

DISTRIBUTION. Known only from Malaysia and Singapore. 31 specimens examined: 28♂, 2♀, 1 L; 2 with associated immature skins (1 p, 1 lp).

MALAYSIA. *Peninsular Malaysia - Selangor:* Kuala Lumpur (type-locality), Ulu Klang; Trengganu: Kemaman; 5♂, 1♀. *Malaysia - Sarawak:* Kuching; Sabah: Kota Kinabalu; 4♂.

SINGAPORE. Pulau Blakang Mati; 1♂, 1♀, 1 L, 1 p, 1 lp; unspecified locality; 18♂ (A. R. Barr collection).

TAXONOMIC DISCUSSION. The males of *eminentia* which I have examined all agree well with the description by Colless (1965: 298). The most distinctive features are the relatively long palpus which is the longest among the members of the *brevipalpus* complex; the large yellowish or golden tuft of flagellomere 5 and the prominent tuft of 10-12 dark, long, flattened setae of flagellomere 9 of the antenna and the absence of seta *h* (basal seta of Colless) on the subapical lobe of the basimere of the genitalia. The pupa is indistinguishable from *lucaris*, but is distinct from *brevipalpus* and *acutipalus* in having most setae of cephalothorax and abdomen relatively shorter and weaker. The larva closely resembles *brevipalpus* more than *lucaris* and *acutipalus*. It can be separated from *brevipalpus* by the more widely spaced seta 4-C and the relatively weaker and short setae 1-8-P.

BIONOMICS. *Culex eminentia* is apparently less common than the other 3 members of the *brevipalpus* complex. As in *brevipalpus* and *lucaris*, its occurrence is restricted to a lowland, open, scrub or secondary forest at elevations from sea level to about 60 m. In Peninsular Malaysia and Singapore, the larvae were collected 3 times from *Nepenthes ampullaria* and once from *gracilis*. In Singapore, Barr and Chellapah (1963) reported that the larvae were most frequently found in *N. gracilis*.

53. *CULEX (LOPHOCERAOMYIA) ACUTIPALUS* COLLESS
(Fig. 68)

Culex (Lophoceraomyia) acutipalus Colless 1965: 299 (♂*, ♀, L).

FEMALE. As described by Colless (1965: 299-300), differing slightly from *brevipalpus*, *lucaris* and *eminentia* in the following features. *Head*. Narrow decumbent scales of vertex entirely blackish; lateral patch of broad scales at side of eye blackish; erect scales darker, dull golden brown to dark brownish. *Thorax*. Upper corner and posterior border of *stp* with some scattered pale scales not aggregating into a definite patch, sometimes scales entirely absent.

MALE (Fig. 68). Differing from other 3 members of the *brevipalpus* complex as described for female and in the following sexual characters. *Palpus*.

Relatively shorter, about 0.5 or less of proboscis length. *Antenna*. Modified tufts of F-5-9 markedly reduced and less conspicuous; F-5 with 4, 5 narrow golden or yellowish brown lanceolate scales; F-8 with a slender sigmoid hooked tuft of 4, 5 fused setae; F-9 with 3, 4 relatively weak bristlelike setae which are not strongly differentiated from long normal setae.

MALE GENITALIA (Fig. 68). As figured, differing from *brevipalpus*, *lucaris* and *eminentia* particularly in the following. *Basimere*. Narrower or not strongly compressed; inner surface laterad of tergomesal margin with more numerous short setae. *Subapical Lobe*. Accessory bladelike setae in group *d-f* associated with seta *a-c* more numerous and densely packed; seta *h* (basal seta of Colless) present, relatively weak and short, its length not as long as or longer than rodlike setae *a-c;* base of boot-shaped seta g_2 apparently without any long, fine, hairlike setae.

PUPA. As described and figured for *brevipalpus* from which it is inseparable; differing from *lucaris* and *eminentia* particularly in having most setae of cephalothorax and abdomen stronger and longer.

LARVA. As described and figured for *brevipalpus*, differing from it and from *lucaris* and *eminentia* by the following combination of characters. *Head*. Seta 4-C situated closer near dorsal midline; 1-C more slender. *Thorax*. Seta 8-P usually triple (2-3); 14-P double or triple, rarely single. *Abdomen*. Seta 7-II weaker and shorter than 6-I, II or 7-I, 5, 6 branched, its length of the same magnitude as 7-III-VI. *Siphon*. Subventral tufts 6, 7 pairs.

TYPE-DATA. Holotype ♂ with associated pupal and larval skins (58/25/2) and slides of antenna (CH 192) and genitalia (CT 666), Swiss Club, Kg. Chantek Bahru, SINGAPORE, 28 November 1958, D. H. Colless (ANIC).

DISTRIBUTION. Known only from Peninsular Malaysia and Singapore. 27 specimens examined: 16♂, 10♀, 1 L; 10 with associated immature skins (4 p, 6 lp).

MALAYSIA. *Peninsular Malaysia - Selangor:* Pacific Tin, K. Sel; *Malacca:* Malacca; 2♂, 5♀, 2 lp.

SINGAPORE. Kg. Chantek Bahru: Swiss Club (type-locality); Ulu Pandan; Pulau Blaklang; 11♂, 5♀, 1 L, 4 p, 4 lp; unspecified locality; 3♂ (A. R. Barr collection).

TAXONOMIC DISCUSSION. Of all stages of *acutipalus*, the male is the most distinct. It can be readily separated from the other 3 members of the *brevipalpus* complex by the reduction of the antennal modified tuft and the more numerous accessory setae *(d-f)* of the subapical lobe of the genitalia. The pupa exhibits no clear-cut difference from that of *brevipalpus*, but can be separated from *lucaris* and *eminentia* by the remarkably stronger setae 5-C and the stronger setae 6-I, II, 5-IV-VI, 6-III-VI and 9-VII-VIII. The larva is most similar to *lucaris* from which it can be separated by the more closely spaced seta 4-C and by the presence of 6 or 7 pairs of siphonal tufts.

BIONOMICS. As in other members of the *brevipalpus* complex, *acutipalus* has also been reported from the open scrub or secondary forest at elevations from sea level to about 30 m. In Singapore, Colless (1965: 300) noted that adults are quite commonly found resting on vegetation in the vicinity of breeding places, but were not taken with mammalian baits. Little is known about which species of the pitcher plants are most frequently utilized as breeding sites. All of the 3 collections recently made in Singapore came from *Nepenthes ampullaria*.

curtipalpis complex

54. *CULEX (LOPHOCERAOMYIA) CURTIPALPIS* (EDWARDS)
(Figs. 69, 70)

Lophoceratomyia curtipalpis Edwards 1914b: 127 (♂).
Culex (Lophoceratomyia) curtipalpis (Edwards), Edwards 1921: 78 [as synonym of *C. (Lophoceratomyia) jenseni* (de Meijere)]; Edwards 1928: 279 (♂*; revalidated); Edwards and Given 1928: 357 (P, L*); Brug and Edwards 1931: 261 (distribution); Brug and Bonne-Wepster 1947: 186 (distribution).
Culex (Lophoceraomyia) curtipalpis (Edwards), Stone, Knight and Starcke 1959: 232 (catalog); Colless 1965: 301 (♂*, ♀, L): Bram 1967a: 76 (♂*, ♀, L*, in part).

FEMALE. Wing: 3.2 mm. Forefemur: 1.8 mm. Proboscis: 2.0 mm. Medium-sized, dark brown to black; in general conforming to the subgroup characters, distinctive in the following. *Head*. Narrow decumbent scales of vertex very fine, largely yellowish brown or black in center, pale whitish along upper eye border, forming a distinct ocular line; lateral patch of broad scales whitish, very distinct; erect scales usually predominantly dark brown to black except for a few pale golden ones on lateral area; sometimes entirely golden or yellowish brown. *Cibarial Armature* (Fig. 69). Cibarial bar moderately broad, with a concave row of 24-30 coarse, short teeth which are rather widely spaced, a few median teeth narrow, terminated into fine apices, lateral teeth larger, flattened, abruptly pointed or truncate apically. *Thorax*. Mesonotal integument deep chestnut brown to almost black. *Apn* with a small but distinct patch of some broad pale or dark scales; *ppl* with or without some broad pale scales; upper corner and posterior border of *stp* with a conspicuous vertical patch of loosely packed broad pale scales; lower *mep* bristle absent. *Legs* and *Wing*. Essentially similar to the rest of the *Mammilifer* Group. *Abdomen*. Terga entirely black scaled except for lateral margin which is slightly paler; sterna pale yellowish scaled.

MALE (Fig. 69). In general as in female with the following distinctive features. *Palpus*. Short, about 0.5 of proboscis length. *Proboscis*. Slender and uniformly thin in basal 0.5, gradually thickened in apical 0.5. *Antenna*. Pedicel with a blunt spiculose prominence on inner dorsal surface; flagellar whorls moderately plumose; modified tufts of F-5-9 present, poorly developed or strongly reduced in size, most of which are apparently restricted to ventral and mesal surfaces; F-5 with a small tuft of 5, 6 modified setae, 3, 4 setae on lateral dorsal surface short, slightly longer than the length of one flagellomere, followed ventrally by 2 longer, flattened, scalelike setae which are about as long as the combined length of next 4 flagellomeres; F-6 with a small tuft of 4 weakly curled setae; F-7 with a lateral comb-shaped tuft of 4, 5 slender, subapically hooked setae and a mesal tuft of 2-4 straight acute setae; F-8 with a weakly curved tuft of 3-5 stout, fused setae; F-9 with 2-5 weak bristlelike setae.

MALE GENITALIA (Fig. 69). As figured. *Segment IX*. Tergal lobe poorly developed, bearing 2, 3 short, weak setae; sternum with a transverse row of 5, 6 strong setae towards caudal margin. *Basimere*. Stout, broad oval-shaped, about 0.25 mm in length; inner tergal surface lightly convex, with several subequally strong setae on tergomesal margin and outer area laterad of subapical lobe. *Subapical Lobe*. Prominent, elongate. projecting mesad;

rodlike setae *a-c* rather short, stout, subequally long; seta *a* (most ventral) strongest, distally curved upwards; *b-c* slender and slightly curved downwards; setae in group *d-f* consist of 3 strong, sharply bent blades and 2 smoothly curved blades; seta g_2 (or leaflet) not developed or replaced by one of the setae in group *d-f;* leaflet g_1 very broad, heart-shaped, distad of setae *d-f;* seta *h* moderately long, closely adjacent to leaflet g_1; numerous fine hairlike setae present basad and mesad of leaflet g_1. *Distimere*. Rather thick with modified, expanded truncate apex; subapical claw short, small and apically blunt, situated close to the recurved point; dorsal and ventral subapical seta tiny, opposite each other. *Phallosome*. Strongly sclerotized; internal process shorter than external process; latter broad, with distinct spiculate apical lobe (or knob) and 1-3 rows of 15 or more strong denticles on upper tergal surface. *Proctiger*. Apical crown well developed, medium-sized, composed of several strong spinelike spicules; cercal setae 3-5.

PUPA (Fig. 69). Abdomen: 2.9 mm. Paddle: 0.5 mm. Trumpet: 0.28 mm; index 2. Cephalothorax and abdomen usually dark brown, sometimes pale cream-colored; complete chaetotaxy as figured, most setae weakly developed, distinctive in the following. *Trumpet*. Dark brown, very short, bell-shaped, apex not reaching beyond posterior margin of mid-dorsal ridge in flat preparation. *Cephalothorax*. Setae 1-9-C weakly developed; 1-C single; 2, 3-C triple; 4-C double; 5-C double; 6-C double; 7-9-C single. *Metanotum*. Seta 10-C usually triple (2-3); 11-C single; 12-C single or double. *Abdomen*. Seta 2-I 3, 4 branched; 3-I 1-3 branched, weak, as long as 2-I, situated close to 4, 5-I; segment II with or without a spiniform seta (10-II?) on ventral surface; 1-II-VII very weak, double or triple; 3-II usually triple (2-3); 3-III dark, strong, single; 6-III-VI weak, short, usually double; 5-IV dark, strong, as long as segment following, usually single (1-2); 5-V, VI single, short, about 0.3 of segment following; 9-III-VI minute, single, somewhat spiniform; 9-VII dark, strong, double or triple; 9-VIII dark, stronger and longer than 9-VII, 4, 5 branched. *Paddle*. Rather short and largely pale except at extreme base; apex lightly to strongly emarginate; midrib poorly developed; seta 1-P present; 2-P absent.

LARVA (Fig. 70). Head: 0.60 mm. Siphon: 0.24 mm; index 1.5. Saddle: 0.30 mm; siphon/saddle ratio 0.8. Complete chaetotaxy as figured; pigmentation pale whitish with variable amount of greenish tinge; strikingly different from the larvae of other pitcher plant species in having siphon shorter than saddle and in the following. *Head*. Length greater than maximal width, more or less resembling an *Aedes;* labrum narrow; seta 1-C short, stout, apically blunt or abruptly pointed, situated on a distinct tubercle; 4-C usually single, 2 times as long as distance between bases of the pair; 5, 6-C weak, cephalad, usually triple, each (2-4); 7-C subequal to 5, 6-C, double or triple; 8-9-C minute, cephalad; 10, 11-C weakly developed; 13-C strong and long, usually double or triple (1-3). Antenna pale, very slender, uniform in width, about 0.5 of head length; spicules absent; seta 1-A weak, 3, 4 branched, situated slightly beyond the midpoint of antennal shaft; 2-6-A very weak, all placed apically. Mental plate with 6, 7 lateral teeth on each side of a small median tooth. Mouth brush relatively short and rather coarse. *Thorax*. Spicules absent; seta 4-P usually single, sometimes double; 7-P single or double; 8-P extremely minute, rather inconspicuous, single; 14-P single; 5-M single; 8, 9-M 3, 4 branched; 7, 9-T 3, 4 branched. *Abdomen*. Not spiculate, all setae except setae 6-I-VI, 7-I, II and 13-VII extremely weak and inconspicuous; 6-I-III usually triple (2-3); 6-IV-VI double; 7-I, II both as strong as seta 6, double; 13-VII double, remarkably strong, of the same magnitude as setae 6 or 7. Comb scales 4-10, in a single row, all broad, subequal, with rounded

apical fringe of evenly fine spicules; setae 1, 2 and 4-VIII minute, single or double; 3 and 5-VIII dark, strong, flattened; 3-VIII double or triple; 5-VIII single. Saddle broad; seta 2-X dark, with 5, 6 strong branches; 4-X (ventral brush) with 6 pairs of setae; anal gills fusiform, as long as saddle. *Siphon.* Short, stubby and small, pecten teeth short, broad, 2-4, all simple; subventral tuft 3 pairs; first 2 proximal pairs strong, subequal, usually 4, 5 branched (3-4), as long as or slightly longer than siphonal width at point of attachment; most distal pair weaker and shorter, 5 branched; dorsal valve of spiracular apparatus broad with a strong hooked seta (seta 9?); median caudal filament absent.

TYPE-DATA. Holotype ♂* (marked as type by Edwards) with slide of genitalia, Kuching, *Sarawak,* [MALAYSIA], 6 March 1914, J. C. Moulton (BMNH).

DISTRIBUTION. Thailand, Malaysia and Singapore; also reported from Sumatra and Kalimantan (Borneo), Indonesia. 185 specimens examined: 113♂, 64♀, 8 L; 39 with associated immature skins (14 p, 25 lp).

THAILAND. *Ranong:* Hard Sam Pan; Ban Phon Rang; *Patthalung:* Muang; 6♂, 3♀, 1 L, 3 p, 6 lp.

MALAYSIA. *Peninsular Malaysia - Malacca:* Malacca; *Johore:* Kota Tinggi; *Trengganu; Kemaman;* 28♂, 17♀, 7 L, 2 p, 13 lp. *Malaysia - Sarawak:* Kuching (type-locality); Sabah: Kota Kinabalu; 16♂.

SINGAPORE. Mandai Rd.; other unspecified localities; 52♂, 42♀, 9 p, 6 lp; 11♂ and 2♀ (A. R. Barr collection).

Additional records from the literature. INDONESIA. *Sumatra:* Padang (Brug and Edwards 1931: 261); *Kalimantan* (Brug and Bonne-Wepster 1947: 186).

TAXONOMIC DISCUSSION. *Culex curtipalpis* is apparently one of the most common pitcher plant forms in Malaysia and Singapore with the range extending north as far as southern Thailand. The specimens collected by H. H. Stage, P. J. Santana and others in Vietnam, which were recorded by Bram (1967a: 77) as *curtipalpis* are incorrect. I have reexamined these specimens and found them to be *sumatranus*. Both species are exceedingly similar in all stages except for the development of the modified tufts of the male antenna, which are present in *curtipalpis* but entirely absent or largely degenerate in *sumatranus*.

All stages of *curtipalpis* except for the female are most distinctive and can readily be recognized by several features as indicated in the keys and as given in the above diagnosis. The female is generally very similar to the members of the *brevipalpus* complex, from which it can be separated by the presence of broad, loosely packed vertical patch of pale scales on the upper corner and posterior border of sternopleuron and by the more numerous cibarial teeth. Most of the diagnostic features of *curtipalpis* are remarkably constant and there is no indication of local or geographical differentiation among the material examined.

BIONOMICS. The immatures of *curtipalpis* have been frequently collected from *Nepenthes gracilis* in open or partial shaded scrub or secondary rain forest at sea level to about 40 m (Barr and Chellapah 1963). At Mandor, near Pontianak, western Borneo (Kalimantan), it was also reported from *Nepenthes mirabilis* (Brug 1934: 150). Of the 4 larval collections recently made in Peninsular Malaysia, 3 were from *N. gracilis* and one from *ampullaria*. In Sabah, and Sarawak, numerous adults were collected while resting on leaves of plants under heavy shade of tropical forest. In Singapore, Colless (1965: 302) noted that the adults were found resting near the breeding places and exhibited no attempt to feed on bait animals.

55. *CULEX (LOPHOCERAOMYIA) SUMATRANUS* BRUG
(Fig. 70)

Culex (Culex) sumatranus Brug 1931: 248 (♂, L); Brug and Bonne-Wepster 1947: 187 (distribution).
Culex (Neoculex) sumatranus Brug, Brug and Edwards 1931: 261 (distribution); Stone, Knight and Starcke 1959: 229 (catalog).
Culex (Lophoceraomyia) curtipalpis (Edwards), Bram 1967a: 76 (in part).
Culex (Lophoceraomyia) sumatranus Brug, Sirivanakarn 1971: 62 (taxonomy).

FEMALE. Wing: 2.7 mm. Forefemur: 1.5 mm. Proboscis: 1.8 mm. Extremely similar to *curtipalpis*, differing slightly in smaller size, paler coloration and in the following. *Head*. Erect scales entirely pale yellowish brown or golden. *Thorax*. Mesonotal integument pale brown or reddish brown.

MALE (Fig. 70). As described for *curtipalpis*, differing from it particularly in the following. *Antenna*. Flagellar whorls weakly plumose or composed of relatively fewer long setae; modified tufts of setae and/or scales on F-5 to F-9 entirely absent or not developed; F-7 sometimes with a rudimentary or inconspicuous tuft of 4 very short setae on mesal surface.

MALE GENITALIA. As described and figured for *curtipalpis* from which it can not be distinguished with certainty, differing slightly in having relatively smaller basimere and less expanded modified apex of distimere.

PUPA. Essentially as described and figured for *curtipalpis* from which it differs slightly in smaller size and in pale, cream-colored cephalothorax and abdomen.

LARVA. As described and figured for *curtipalpis* from which it is virtually indistinguishable.

TYPE-DATA. Holotype ♂* (18.140, marked as type by Brug 1931) with slide of antenna and genitalia, Dermajoe, Benkoelen, *Sumatra*, [INDONESIA], Nov.-Dec., 1929, S. L. Brug (BMNH).

DISTRIBUTION. Hong Kong, Vietnam, Cambodia and Indonesia. 249 specimens examined: 56♂, 45♀, 3 L, 68 p, 77 l; 26 with associated immature skins (3 p, 23 lp).

HONG KONG. 4♂, 4♀, 3 l (associated with the adults).

VIETNAM. Saigon; Bien Hao; Kontum; Baria; Thoutum; Djiring; Danang; 48♂, 41♀, 3 L, 68 p, 77 l, 23 lp.

CAMBODIA. Phu Quoc Island; 3♂ (genitalia only).

INDONESIA. *Sumatra:* Dermajoe, Benkoelen (type-locality), 1♂ (holotype).

TAXONOMIC DISCUSSION. *Culex sumatranus* was very poorly known until I re-examined the male holotype at the BMNH and transferred it from *Neoculex* to *Lophoceraomyia* (Sirivanakarn 1971: 62-85). As pointed out by Barraud (1934: 351, footnote), there has been some confusion in associating the larvae and adults of this species. Brug's description and figure of *sumatranus* larvae (Brug 1931: 248) were apparently in error. However, judging from his figure, the specimens probably belong to *hewitti* which, on the basis of its occurrence and breeding habitat might be found with *sumatranus* in the same pitcher plant. The association of the males and larvae of *sumatranus* by R. B. Jackson in Hong Kong (in Barraud's footnote, p. 351) is undoubtedly correct. I have checked this material against the type-male and numerous males with associated larvae from Vietnam and found them agreeing well with the brief diagnosis by Barraud (loc. cit.).

All stages of *sumatranus* are exceedingly similar to and indistinguishable

from *curtipalpis* except for the male which differs from the latter rather strikingly in the absence of the modified tufts of the male antenna. Both species have been reported from Sumatra (Brug and Edwards 1931: 261) but have not yet been found occurring together in Vietnam and Hong Kong.

BIONOMICS. The single collection of the male type (Brug 1931: 248-9) and numerous collections of the reared specimens of *sumatranus* from Vietnam as well as a few from Hong Kong and Cambodia were from pitcher plants, species unknown. All of these collections were made at a low elevation along the coast.

WILFREDI GROUP

The *Wilfredi* Group is a complex of 3 closely similar species: *wilfredi* Colless, *pilifemoralis* Wang and Feng and *hirtipalpis* n. sp. All stages of the *Wilfredi* Group are characterized below in the description of *wilfredi*. The group is strongly differentiated from the other 2 major groups: *Fraudatrix* and *Mammilifer*, especially in the male by apical 0.25-0.50 of forefemur with a dense tuft of several strong setae or bristles on anterior surface and in the male genitalia by the large compact, barrel-shaped and heavily denticulate phallosome. Both features are unique but the latter, somewhat resembles those of the *tenuipalpis* Subgroup of *Eumelanomyia* (Sirivanakarn 1971: 47-8). In the general external characters of the adults, the females are apparently more similar to the *Mammilifer* Group than to the *Fraudatrix* Group in having the decumbent scales of vertex of the head and the scales on wing veins R_2 and R_3 narrow, linear and fine. The males are similar to the *Fraudatrix* Group in the absence of nipplelike prominence on the antennal pedicel, the presence of modified tufts of scales and setae on antennal flagellomeres 5-10, the development of broad, bladelike scales of the modified tuft of antennal flagellomere 9 and in the presence of a distinct false joint at 0.25 from the base of proboscis but share with the *Mammilifer* Group in the absence of the basal fingerlike processes of palpus and the absence of dorsal upright setae in the distal portion of proboscis. Except for the unique phallosome, all other features of the male genitalia, including particularly the proctiger crown are essentially similar to most members of the *Mammilifer* Group. The known pupae and larvae, which occur primarily in general ground pools, both exhibit much overlap with the *Fraudatrix* and *Mammilifer* groups in general and detailed chaetotaxy. The pupae are rather similar to the *Fraudatrix* Group and certain ground pool forms of the *Mammilifer* Group in having pinna of the trumpet with a slit extending into the meatus, setae 5-IV 3-6 branched and 6-III-VI usually 4, 5 branched. The larvae show a strong affinity with the *Mammilifer* Group in having seta 4-C and seta 1-M relatively strong and long, and seta 8-P single, but share with most members of the *Fraudatrix* Group in having seta 14-P single.

The *Wilfredi* Group is known only from Peninsular Malaysia, Thailand, Vietnam and southern China.

KEYS TO SPECIES[1]

FEMALES
(Separation not reliable, see keys to males, pupae and larvae)

1. Decumbent scales of vertex entirely narrow, linear and fine. *wilfredi*
Decumbent scales of vertex relatively broad clavate on anterior dorsal margin, narrow and fine in center. . . . . *pilifemoralis*

MALES

1. Palpal segment 3 with prominent rows of numerous setae in apical 0.5. . . . . *hirtipalpis*
Palpal segment 3 without prominent rows of numerous setae in apical 0.5. 2

2(1). Proboscis with 2-4 long setae on ventral surface distad of false joint; anterior surface of forefemur with 10-12 strong setae forming prominent tuft in apical 0.25-0.50. . . . . *pilifemoralis*
Proboscis without any long setae on ventral surface; anterior surface of forefemur usually with 20 or more strong setae forming prominent tuft in apical 0.5 or more. . . . . *wilfredi*

MALE GENITALIA
(Inseparable, see keys to males, pupae and larvae)

PUPAE

1. Seta 8-C usually 4, 5 branched. . . . . *wilfredi*
Seta 8-C usually double. . . . . *pilifemoralis*

LARVAE

1. Setae 6-III-VI 3, 4 branched; seta 2-X usually triple. . . . . *wilfredi*
Setae 6-III-VI 5 branched; seta 2-X usually double. . . *pilifemoralis*

56. *CULEX (LOPHOCERAOMYIA) WILFREDI* COLLESS
(Figs. 71, 72, 73)

Culex (Lophoceraomyia) wilfredi Colless 1965: 297 (♂*); Bram 1967a: 110 (♂*, ♀, L*; in part).

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[1]Female, pupa and larva of *hirtipalpis* are unknown.

FEMALE. Wing: 3.0 mm. Forefemur: 1.6 mm. Proboscis: 1.9 mm. Medium-sized, general coloration brownish to blackish; in general essentially conforming to the description of the subgenus with the following diagnostic features. *Head*. Decumbent scales on dorsum of vertex entirely narrow, linear and fine, scales on upper eye margin pale whitish, forming a narrow distinct ocular line; erect scales narrow, slender and entirely dark brown; lateral patch of broad scales paler whitish to grayish. Proboscis with 4 labial basal setae, 2 lateral ones about 0.5 of palpal length. *Cibarial Armature* (Fig. 71). Cibarial bar with a concave row of 50 or more narrow, elongate teeth which are closely spaced, subequal and abruptly pointed apically. *Thorax*. Mesonotal integument reddish to dark brown; scales narrow, moderately dense, entirely dark brown or almost black. *Apn* with or without a few pale scales; *ppn* with about 10 or less scattered narrow, scalelike setae cephalad of posterior bristles. Pleuron same color as mesonotum; *ppl* with 3 bristles and 5-7 weak setae, scales absent; *stp* with or without a few scattered pale scales on its upper corner; 1, 2 lower *mep* bristles present. *Legs*. Anterior surface of hindfemur with a broad longitudinal whitish stripe extending from base to apex, rest entirely dark. *Wing*. Scales on veins R_2, R_3 narrow, linear. *Abdomen*. Terga entirely black scaled; sterna pale yellowish scaled.

MALE (Fig. 73). Sexually dimorphic, particularly in having a dense tuft of about 20 or more strong bristlelike setae in apical 0.5 of anterior surface of forefemur. *Palpus*. Slender, exceeding proboscis by about full length of segment 5; segment 2 with a dense row of several dark, short setae on lateral and mesal surfaces; segment 3 very thin, with several tiny setae largely restricted to basal 0.25 on ventral surface, its apex bears 3-5 bristles; segments 4, 5 very weakly plumose, bristles sparse or relatively few. *Proboscis*. Uniformly thick; labial false joint present at 0.25 from base, ventral setae distad of joint absent; labial basal setae weak, short, hairlike, about 10 in number. *Antenna*. Pedicel without distinct spiculose prominence on inner dorsal surface; flagellar whorls densely long plumose; modified tufts of setae and scales present on F-5-10; F-5 with a large yellowish or brownish tuft of 8-12 narrow scales which are subequally long, flattened in basal 0.25, linear, hairlike in apical 0.75, as long as the combined length of the next 5-7 flagellomeres, preceded dorsally by 2-5 long normal setae and followed ventrally by 5-7 short acute setae; F-6 with a large crumpled dark brownish tuft of about 15 curled setae; F-7 with a ventral comb-shaped, dark brownish tuft of 8-10 weakly curled setae and a thick dark matted tuft of 5-7 subapically twisted setae on mesal surface; F-8 with a thick dark weakly hooked tuft of 7-10 fused setae, 3, 4 of which are shortened and slightly swollen subapically, the remaining longer, distally tapered and smoothly curved; F-9 with 3-5 narrow yellowish bladelike scales on lateral surface and several strong bristlelike setae on ventral and mesal surfaces; F-10 usually with 3-4 dark, long bristlelike setae, sometimes absent or not well differentiated from normal long setae.

MALE GENITALIA (Fig. 71). *Segment IX*. Tergal lobe small, bearing 3, 4 moderately strong setae; sternum with 10-17 strong setae in an irregular transverse row towards caudal margin. *Basimere*. Slender, conical, about 0.30 mm in length; inner tergal surface with a linear row of 5, 6 strong submarginal setae and a few other weaker setae basad; marginal setae 7-10, about 0.5 of length of submarginals. *Subapical Lobe*. All usual specialized setae and leaflets present; rodlike setae *a-c* subequal, largely overlapping; setae *d-f* strong, 5, 6 in number, all flattened, bladelike, weakly bent dorsad; leaflet g_2 narrow, slightly longer and broader than setae *d-f;* leaflet g_1 lanceolate, shorter or subequal to leaflet g_2; seta *h* strong, situated close to bases of

setae *a-c*. *Distimere*. Slender, normal, distally tapered into a slender recurved apex; subapical claw small; ventral and dorsal subapical seta present, minute, situated opposite each other. *Phallosome*. Large, dark, compact, barrel-shaped and strongly sclerotized, tergal surface heavily denticulate; lateral plate rectangular in lateral aspect, with a short strongly denticulate internal process basad. *Proctiger*. Apical crown large, composed of several coarse spinelike spicules; paraproct and cercal sclerite broad, well sclerotized; cercal setae 3, 4.

PUPA (Fig. 71). Abdomen: 2.6 mm. Paddle: 0.65 mm. Trumpet: 0.62 mm; index 10-12. Cephalothorax and abdomen more or less uniformly pale cream-colored or slightly darkened. *Trumpet*. Slender, long, apex lightly to moderately widened; pinna with slit extending to meatus. Complete chaetotaxy as figured; all setae well developed. *Cephalothorax*. Seta 1-C usually 4 branched (4-6); 3-C usually triple (2-4); 5-C usually 6 branched (5-8); shorter or subequal to 7-C; 8-C usually 4, 5 branched (3-5); 9-C usually triple (3-5). *Metanotum*. Setae 10, 11-C double; 12-C usually 4 branched (3-4). *Abdomen*. Seta 1-II dendritic or multibranched; 1-III, IV usually 9 branched (7-11); 1-V usually 6 branched (5-8); 1-VI usually 5 branched (4-7); 1-VII usually 4 branched (3-5); 3-I-III double; 5-IV usually 4 branched (3-6), as long as segment following; 5-V usually double (2-3), about 1.5 times as long as segment following; 5-VI double, subequal to 5-IV; 6-III-VI usually 4, 5 branched (3-6); 9-VII usually triple (2-3); 9-VIII 4-7 branched. *Paddle*. Broad, pale whitish to almost transparent; midrib weak, lightly pigmented; setae 1, 2-P present, minute.

LARVA (Fig. 72). Head: 0.78 mm. Siphon: 1.8 mm; index 9-10. Saddle: 0.34 mm; siphon/saddle ratio 5. Generally similar to most members of the *Fraudatrix* and *Mammilifer* groups, complete chaetotaxy as figured. *Head*. Pale yellowish; seta 1-C relatively long, slender, spiniform, its length usually as long as distance between bases of the pair, or sometimes slightly shorter; 4-C single, strong, about 2 times as long as distance between bases of the pair; 5, 6-C strong, subequal, reaching well beyond mouth brush; 5-C usually double (2-3); 6-C double; 7-C usually 6 branched (5-7); 10-C double; 11-C 4, 5 branched; 13-C usually 6 branched (4-7); 14-C 2-6 branched; 16, 17-C developed. Antenna relatively long, nearly as long as head; pigmentation entirely pale as head capsule; spicules numerous, rather fine; seta 1-A large, strongly plumose; 2, 3-A strong, rather long, bristlelike, situated subapically. Mental plate with 6, 7 lateral teeth on each side of median tooth. *Thorax*. Spicules absent; seta 3-P single; 4-P double; 7-P usually double, sometimes triple; 8-P single, subequal to 7-P; 14-P single; 1-M long, usually single (1-2), subequal to 3-M; 8, 9-M 4, 5 branched; 7-T usually 6 branched; 9-T 5, 6 branched; 13-T usually 5 branched (4-7). *Abdomen*. Spicules absent; setae 6-I, II triple; 7-I double; 6-III-V usually 4 branched (3-4); 6-VI usually triple (3-4); 1-III-VI usually 4 branched (3-4); 1-VII usually 5 branched (5-7); 1, 5-VIII 4 branched; 2-VIII single; 3-VIII usually 7 branched (6-7). Comb scales numerous, 44-50, all apparently subequal, with rounded apical fringe of evenly fine spicules. Saddle complete, lightly spiculate on posterior caudal margin; seta 1-X 3, 4 branched; 2-X usually triple (2-3); anal gill slender, fusiform, 1.5 times as long as saddle. *Siphon*. Slender, long, lightly tapered in distal portion; pale yellowish, concolorous with head capsule and saddle; pecten teeth 10-12, 4, 5 distal teeth with a fine barb of 5-7 graded denticles; subventral tufts 4 pairs, all weak, subequal, usually double (1-2), slightly shorter than siphonal width at point of attachment; median caudal filament of spiracular apparatus dark, very distinct.

TYPE-DATA. Holotype ♂* with slides of antenna (CH 190) and genitalia (CT 646), Malaya [MALAYSIA], date and collector not specified (ANIC).

DISTRIBUTION. Known only from Peninsular Malaysia and Thailand. 152 specimens examined: 68♂, 33♀, 51 L; 42 with associated immature skins (11 p, 31 lp).

THAILAND. *Chiang Mai:* Doi Sutep; *Lampang:* Ngao; Tak: Doi Sam Sao; *Nakhon Ratchasima:* Ban Tha Ma Prang; *Nakhon Nayok:* Khao Yai, Khao Kheow; *Chanthaburi:* Khao Sai Dao; 49♂, 9♀, 47 L, 11 p, 18 lp.

VIETNAM. Ban Me Thuot; 1♂.

MALAYSIA. *Peninsular Malaysia*. Locality unspecified; 1♂ (holotype); *Pahang:* Gunong Benom; Cameron Highlands; *Perak:* Cameron Highlands Rd.; 17♂, 24♀, 4 L, 13 lp.

TAXONOMIC DISCUSSION. *Culex wilfredi* was tentatively assigned to the *Mammilifer* Subgroup of the *Mammilifer* Group by Colless (1965: 297-8), an interpretation subsequently followed by Bram (1967a: 110-3). Although *wilfredi* apparently shares with the *Mammilifer* Group several features of the male and larva as pointed out by the latter author and as indicated in the above discussion of the *Wilfredi* Group, the unique male features, including particularly the extraordinary type of the phallosome, the peculiar development of a prominent tuft of several strong setae on the forefemur, the absence of distinct spiculose prominence on the antennal pedicel and a few other features shared with the *Fraudatrix* Group, strongly suggest that it represents a distinct lineage of *Lophoceraomyia*. On this basis, *wilfredi* and its closely similar forms, *pilifemoralis* and *hirtipalpis*, are considered as belonging to a separate group or *Wilfredi* Group. For the separation of *wilfredi* from *pilifemoralis* and *hirtipalpis*, see the keys and the description of the latter 2 species.

BIONOMICS. *Culex wilfredi* is restricted to mountainous areas at elevations from 500-1,500 m. The immatures have been frequently found in small ground pools at stream margins or stream pools and occasionally in puddles, marshy depressions, seepages and animal foot prints under partial or heavy shade of primary tropical forest. In Perak, Peninsular Malaysia, one collection (No. 1574) was reported to come from a bamboo internode, but this is probably an error due to contamination. The tree hole collection noted by Bram (1967a: 113) in Thailand also appears to be an error as there has been no record from this habitat in all collections from that area. The 2 type-males from Malaysia (Malaya) noted by Colless (1965: 298) to be associated with a collection in pitcher plants were probably from ground pools on the basis of the present records. At Doi Sutep, Chiang Mai, Thailand, several adult males were collected resting near the breeding sites, especially among vegetation along stream margins.

57. *CULEX (LOPHOCERAOMYIA) PILIFEMORALIS* WANG AND FENG (Fig. 73)

Culex (Lophoceratomyia) pilifemoralis Wang and Feng 1964: 37 (♂*).
Culex (Lophoceraomyia) wilfredi Colless, Bram 1967a: 110 (♂*, ♀, L*, in part).

FEMALE. Wing: 2.8 mm. Forefemur: 1.3 mm. Proboscis: 1.7 mm. Extremely similar to *wilfredi* from which it cannot be distinguished with certainty, differing slightly in smaller size and in having broader decumbent scales on ocular line of vertex.

MALE (Fig. 73). In general as in female, differing from *wilfredi* particularly in the following features. *Palpus*. As long as or slightly longer than proboscis; segment 2 apparently without conspicuous rows of dark, short setae on lateral and mesal surface. *Proboscis*. Labium with 2-4 long ventral setae distad of false joint, these setae are 4, 5 times as long as labial width at point of attachment. *Antenna*. Flagellar whorls moderately plumose; modified tuft of F-5 apparently smaller, shorter, whitish or yellowish, but not brownish; composed of 10-12 narrow scales, dorsalmost 4-7 scales short, hairlike or somewhat lanceolate, as long as the length of 1 flagellomere, next 4, 5 scales long, linear, as long as the next 4, 5 flagellomeres, followed ventrally by 4, 5 long, normal setae and mesally by a minute tuft of 6 acute setae. *Legs*. Anterior surface of forefemur with a prominent tuft of 10-12 strong setae in apical 0.25-0.50.

MALE GENITALIA. Essentially as described and figured for *wilfredi* from which it is virtually indistinguishable.

PUPA. Abdomen: 2.2 mm. Paddle: 0.60 mm. Trumpet: 0.60 mm, index 9. As described and figured for *wilfredi*, differing from it particularly in having seta 8-C usually double, or sometimes triple.

LARVA. Based on 3 whole larvae tentatively associated with above pupa and adults. Exceedingly similar to *wilfredi* in general and detailed chaetotaxy, differing from it in the following. *Head*. Seta 1-C shorter, about 0.5 of the distance between bases of the pair. Antennal shaft pale proximally, darkened beyond insertion of seta 1-A. *Abdomen*. Setae 6-III-VI usually 5 branched, sometimes 6; 1-V, VI 5, 6 branched. Saddle seta 2-X usually double (2-3).

TYPE-DATA. Type ♂ (status unspecified), Szemao, Yunnan, CHINA, October 1958, Hsing-Hsiang Wang and Chung-Ying Feng (Dept. Parasitology, Seventh Military Medical College, China).

DISTRIBUTION. Known only from northern Thailand and southern China. 30 specimens examined: 22♂, 5♀, 3 L; 8 with associated pupal skins.

CHINA. Yunnan, as indicated in the type-data (Wang and Feng 1964).

THAILAND. *Chiang Mai:* Doi Sutep; *Lampang:* Ngao; Ban Pho Daeng; 22♂, 5♀, 3 L, 8 p.

TAXONOMIC DISCUSSION. *Culex pilifemoralis* was originally described by Wang and Feng (1964: 40) based on 2 males from Szemao, Yunnan, China. Several males of this species were discovered among numerous specimens previously identified as *wilfredi* by Bram (1967a: 110-3) from northern Thailand. In addition, a number of adults reared from pupae and a few whole larvae have also been obtained from Lampang, Thailand. The assignment of the Thailand material to this species is only provisional, pending a thorough examination of the type which was poorly described. In checking the males from Thailand against the description and figure by Wang and Feng (loc. cit.), I found them agreeing well in the features of the palpus, modified tufts of antennal flagellomeres 5-9 (as segments 6-10 of the authors) and in the number of strong setae on the anterior surface of forefemur. The only discrepancy is in the antennal pedicel which was described by Wang and Feng (as torus) as having a blunt prominence on the inner side. This feature is not developed in male specimens from Thailand except for one slide which exhibits a slightly swollen pedicel due to flat preparation.

Although *pilifemoralis* is exceedingly similar to *wilfredi* and *hirtipalpis*, the differences from the latter 2 species in the male characters as indicated in the key and as described above are constant. In northern Thailand, they were found to be sympatric with one another without any indication of overlap or intergradation in the male diagnostic features.

BIONOMICS. As in *wilfredi, pilifemoralis* occurs at high elevations in mountainous areas and is typically a ground pool breeder. The larvae and pupae have been collected from stream pools, puddles and animal foot prints in the vicinity of forest streams. Most adults were caught while resting on vegetation near their breeding sites.

58. *CULEX (LOPHOCERAOMYIA) HIRTIPALPIS* N. SP.
(Fig. 73)

Culex (Lophoceraomyia) wilfredi Colless, Bram 1967a: 110 (♂*, ♀, L*, in part).

FEMALE. Unknown.

MALE (Fig. 73). Exceedingly similar to *wilfredi* and *pilifemoralis*, differing in the following features. *Palpus*. Segment 3 with prominent lateral and mesal rows of numerous hairlike setae which are very dense and gradually increase in length towards distal portion, proximal setae 2, 3 times as long as segment width, distal ones twice as long as proximals. *Proboscis*. Ventral setae distad of false joint absent, as in *wilfredi*. *Antenna*. Essentially as described and figured for *wilfredi*. *Legs*. Anterior surface of forefemur with more numerous strong setae, forming denser tuft from basal 0.25 to apex, lateral dorsal surface also with a distinct tuft of numerous weaker setae in apical 0.25.

MALE GENITALIA. As figured and described for *wilfredi* from which it is virtually indistinguishable.

PUPA and LARVA. Unknown.

TYPE-DATA. Holotype ♂ (M411-7) with slides of antenna and genitalia, Doi Sutep, near temple, *Chiang Mai*, THAILAND, 13 Jan. 1953, Prayoon Chait and D. C. Thurman (USNM); paratypes: 3♂ (M481-3; M569-273; M462a) with slides of antenna and genitalia, same locality as holotype (USNM).

DISTRIBUTION. Known only from Thailand. Specimens examined: 6♂.

THAILAND. *Chiang Mai:* Doi Sutep; 4♂ (as indicated in the type-data); 1♂ (No. 559, genitalia lost); *Lampang:* Ngao; 1♂.

TAXONOMIC DISCUSSION. The males of *hirtipalpis* were discovered among the numerous specimens identified as *wilfredi* by Bram (1967a: 110-3) from Chiang Mai and Lampang, Thailand. The presence of the prominent rows of long setae on palpal segment 3 and the more numerous setae on the anterior surface of the forefemur in *hirtipalpis* are constant and diagnostic. There is no indication that there is an overlap in these features with the males of either *wilfredi* or *pilifemoralis*.

BIONOMICS. *Culex hirtipalpis* occurs at a high elevation in mountain forests. At the type-locality in Chiang Mai and at Lampang, Thailand, the males were collected resting in association with specimens of *wilfredi* and *pilifemoralis*. The breeding sites are unknown, but most probably are ground pools in dried up stream beds or along the margin of mountain streams.

ACKNOWLEDGMENTS

I am grateful to Dr. Botha de Meillon for his encouragement and assistance during the early phase of this study, and to E. L. Peyton and Ronald A. Ward for continued support in completing the remainder of the work. I am indebted to Donald H. Colless, Division of Entomology, CSIRO, Canberra, Australia; Bruce F. Eldridge, Department of Entomology, Walter Reed Army Institute of Research and Rampa Rattanarithikul, U. S. Army Medical Component - SEATO, Bangkok, Thailand for valuable comments and suggestions in improving the manuscript; Phuangthong Malikul for preparing specimens and numerous slides; John Lane and Thomas V. Gaffigan for curatorial assistance; Chien C. Chang (Department of Entomology, North Carolina State University, Raleigh) for preparing most of the illustrations; Thelma Ford Smith for completing the remainder of illustrations; Helle Starcke and Owilda J. R. Curtis for typing preliminary drafts and Janet D. Rupp for final preparation of text copy for lithoprinting.

I am also grateful to the following individuals and institutions for generous support in sending the material (including some types) on loan or as gifts: Douglas J. Gould, U. S. Army Medical Component - SEATO, Bangkok, Thailand; Shivaji Ramalingam, Department of Parasitology, University of Malaya, Kuala Lumpur, Malaysia; Peter F. Mattingly, British Museum (Natural History), London, England; Donald H. Colless, Division of Entomology, CSIRO, Australia; F. E. Baisas (deceased), Manila, and G. L. Alcasid, National Museum, Manila, the Philippines; A. Ralph Barr, School of Public Health, University of California, Los Angeles; B. N. Mohan, Coonoor, Madras and N. L. Kalra, National Institute of Communicable Diseases, Delhi, India; T. Kurihara, Teikyo University, Tokyo and Yoshito Wada, Nagasaki University, Nagasaki, Japan; J. C. Lien, Taiwan Provincial Malaria Research Institute, Nankang, Taipei; Bernice P. Bishop Museum, Honolulu, Hawaii; Institute Voor Tropische Hygiene, Amsterdam, the Netherlands; Field Museum of Natural History, Chicago; California Academy of Sciences, San Francisco, and the Academy of Natural Sciences, Philadelphia.

Finally, I am thankful to Ronald A. Ward for editing the manuscript.

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39. Pupa, male genitalia and modified tufts of antennal flagellomeres 5 and 8 of *C. ganapathi*.

40. Larva of *C. ganapathi*.

41. Male genitalia and modified tufts of antennal flagellomeres 5 and 8 of *C. spiculosus*.

42. Larva of *C. spiculosus*.

43. Pupa, male genitalia and modified tufts of antennal flagellomeres 5-9 of *C. minor*.

44. Larva of *C. minor;* denticulation of larval pecten teeth of *C. bicornutus*.

45. Male genitalia of *C. bandoengensis* and *tuberis*.

46. Larva, male genitalia and modified tufts of antennal flagellomeres 5-8 of *C. kuhnsi*.

47. Male genitalia and antennal flagellomeres 5-11 of *C. crassicomus*.

48. Male genitalia and modified tufts of antennal flagellomeres 5-9 of *C. incomptus*.

49. Pupa, male genitalia and modified tuft of antennal flagellomere 5 of *C. bengalensis*.

50. Pupa, male genitalia and modified tufts of antennal flagellomeres 5-8 of *C. peytoni*.

51. Larva of *C. peytoni*.

52. Larva, male genitalia and modified tufts of antennal flagellomeres 5-8 of *C. eukrines*.

53. Pupa and male genitalia of *C. pholeter*.

54. Larva of *C. pholeter*.

55. Male genitalia, palpus, proboscis, antennal pedicel and modified tufts of antennal flagellomeres 5-9 of *C. flavicornis*.

56. Larva and pupa of *C. flavicornis*.

57. Pupa, male genitalia and modified tuft of antennal flagellomere 5 of *C. lasiopalpis*.

58. Pupa, female cibarial armature, male genitalia and modified tufts of antennal flagellomeres 5-9 of *C. navalis*.

59. Larva of *C. navalis*.

60. Larva, male genitalia and modified tufts of antennal flagellomeres 5-9 of *C. coerulescens*.

61. Pupa, female cibarial armature, male genitalia and modified tufts of antennal flagellomeres 5-9 of *C. hewitti*.

62. Larva of *C. hewitti*.

63. Pupa, female cibarial armature, male genitalia and modified tufts of antennal flagellomeres 5-9 of *C. jenseni*.

64. Larva of *C. jenseni*.

65. Pupa, female cibarial armature, male genitalia and modified tufts of antennal flagellomeres 5-9 of *C. brevipalpus*.

66. Larva of *C. brevipalpus*.

67. Male genitalia and modified tufts of antennal flagellomeres 5-9 of *C. lucaris* and *eminentia*.

68. Pupa, male genitalia and modified tufts of antennal flagellomeres 5-9 of *C. acutipalus*.

69. Pupa, female cibarial armature, male genitalia and modified tufts of antennal flagellomeres 5-9 of *C. curtipalpis*.

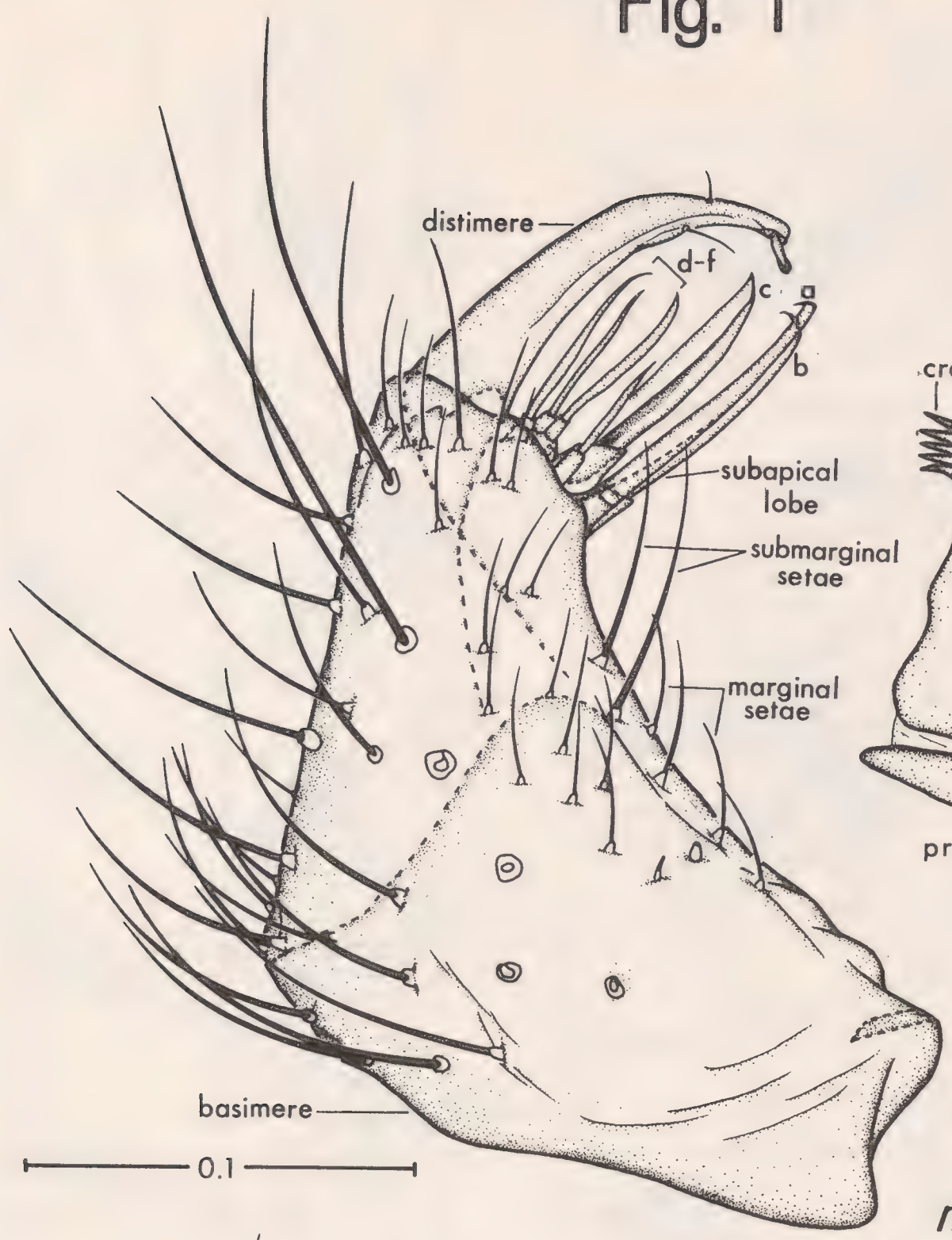
70. Larva of *C. curtipalpis;* male antenna of *C. sumatranus*.

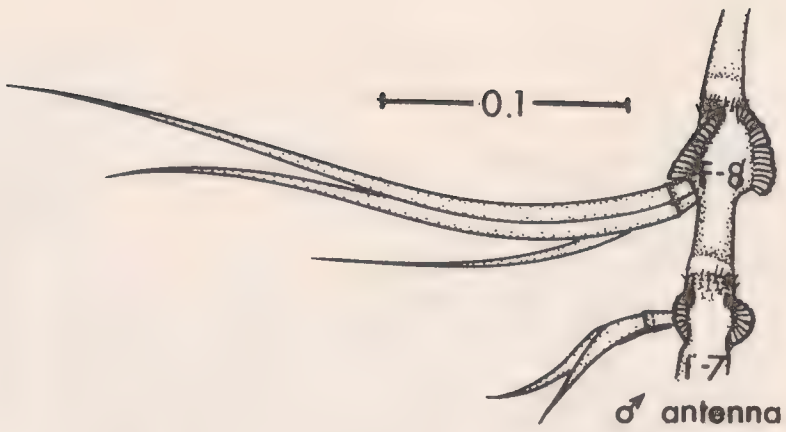
71. Pupa, female cibarial armature and male genitalia of *C. wilfredi*.

72. Larva of *C. wilfredi*.

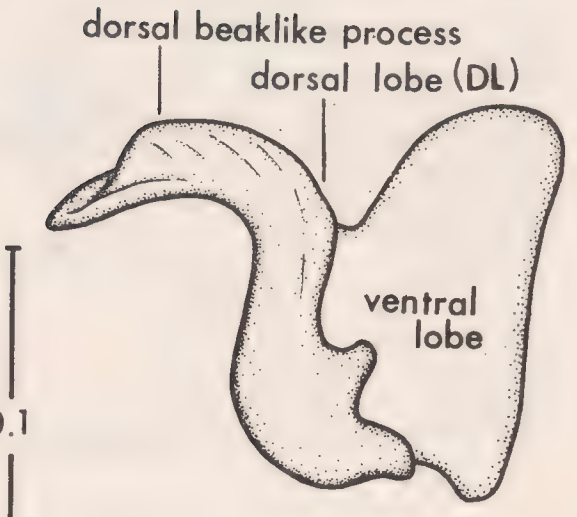
73. Male antenna of *C. wilfredi;* male palpus, proboscis and forefemur of *C. wilfredi*, *pilifemoralis* and *hirtipalpis*.

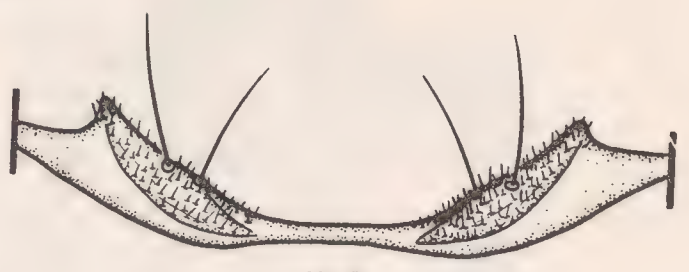
Fig. 1



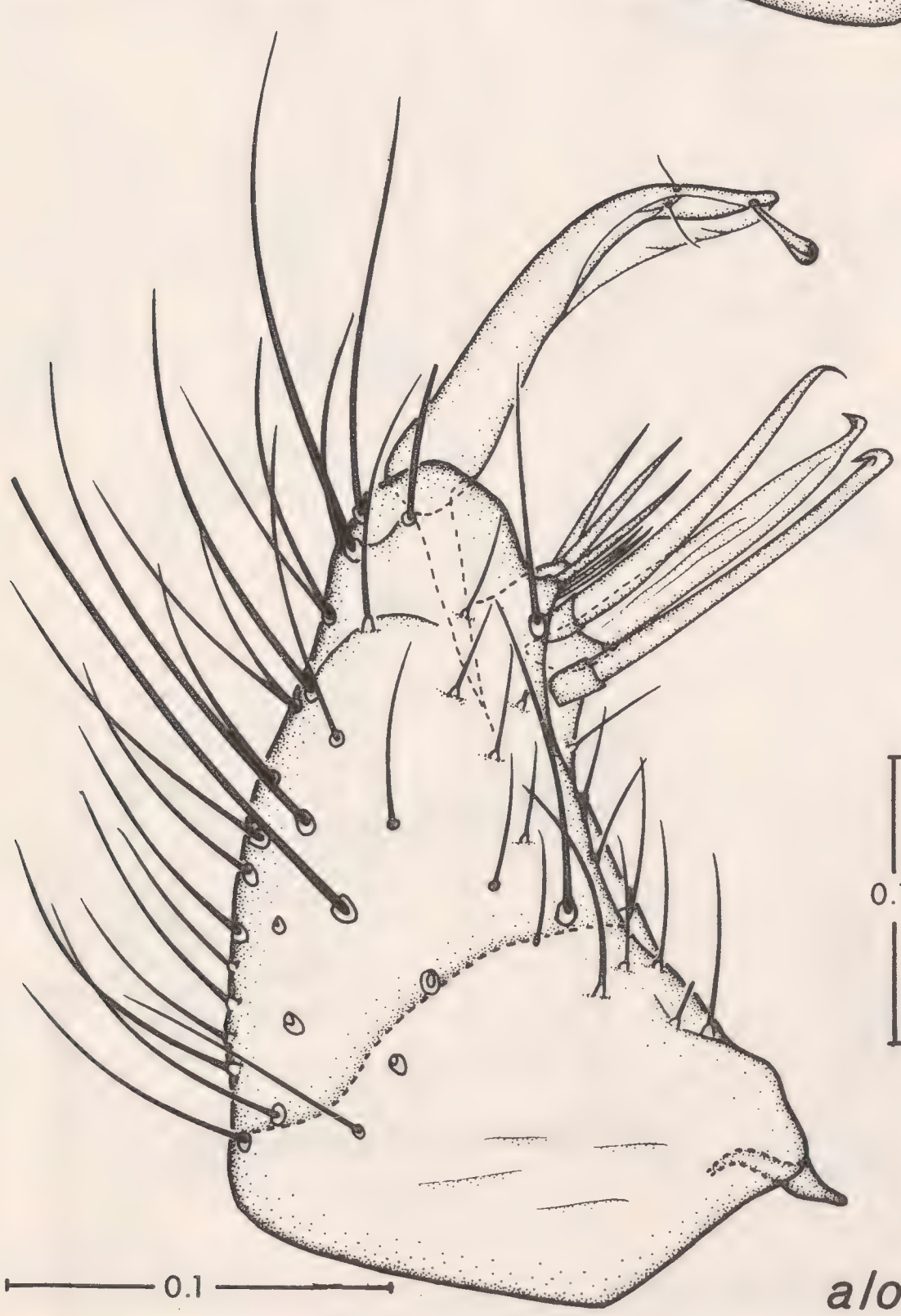


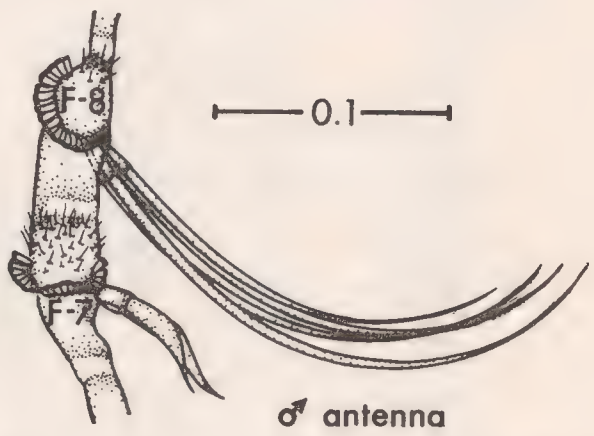




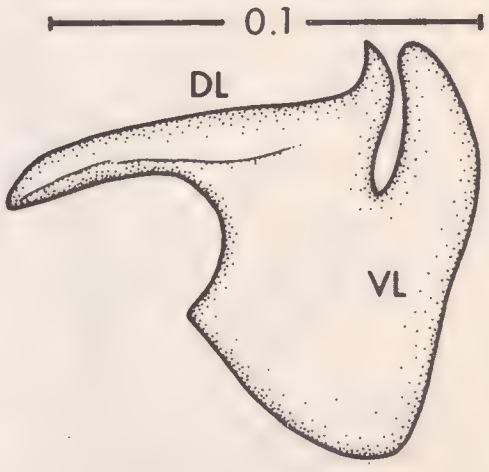


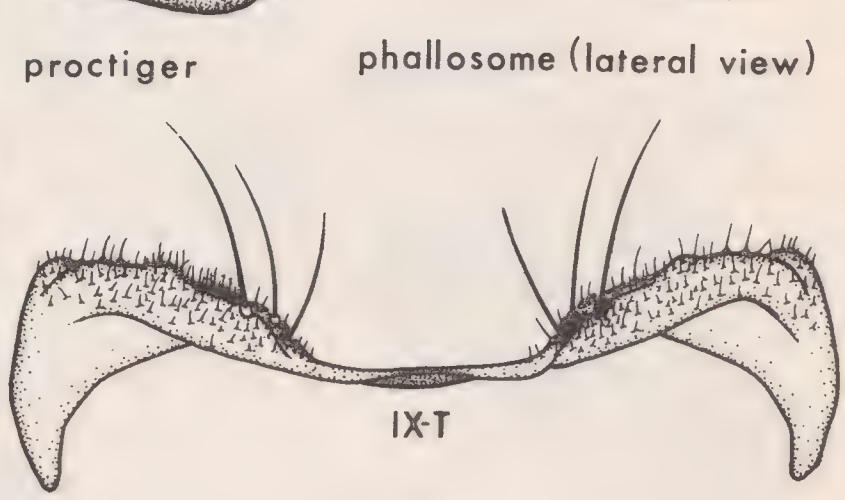
minutissimus







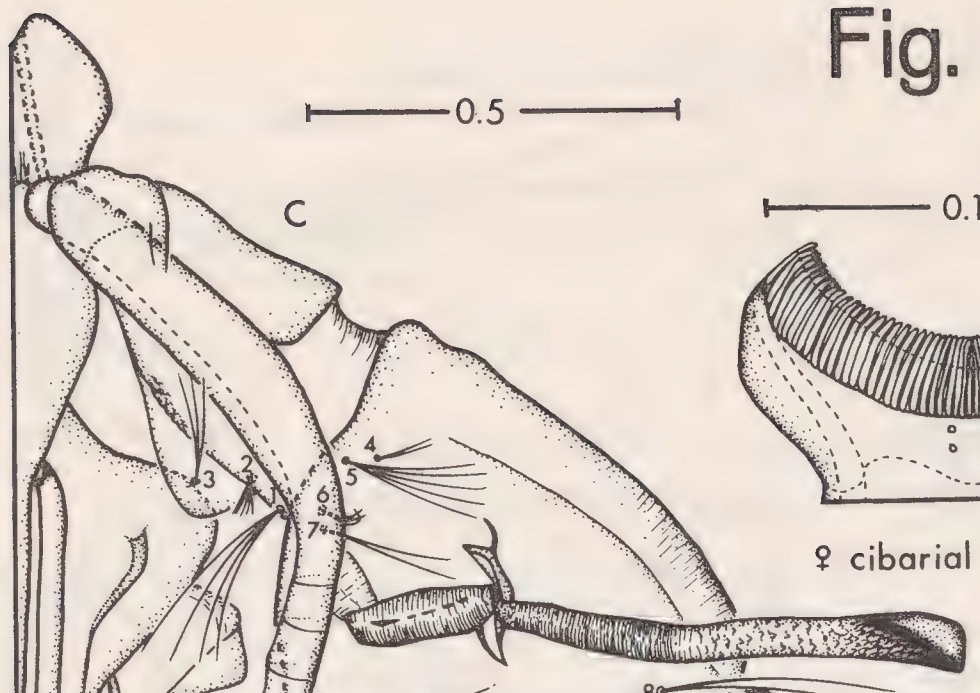




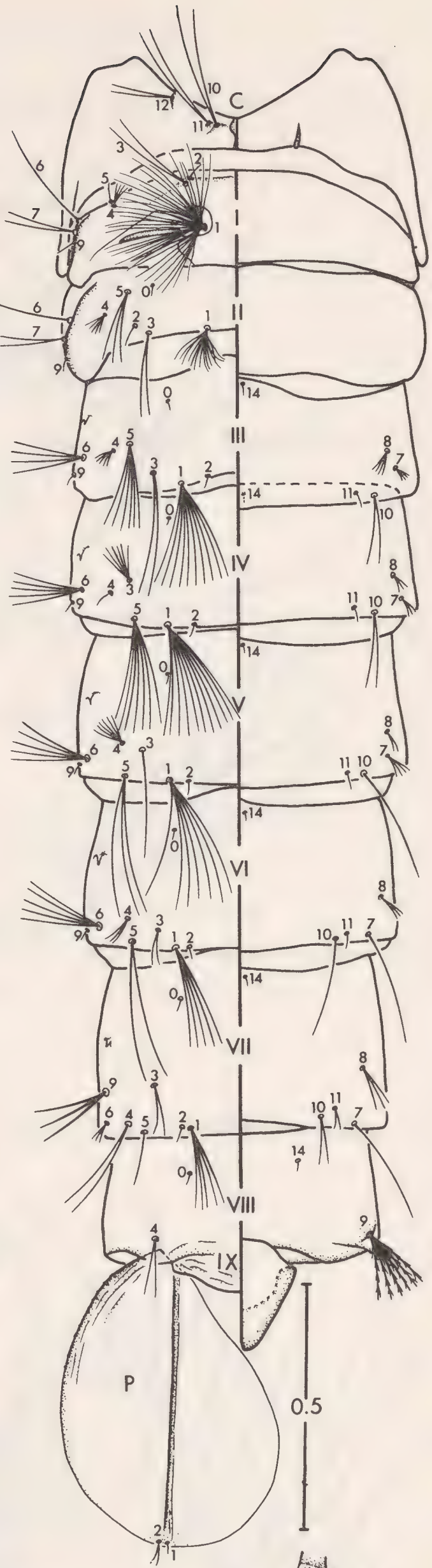
alorensis

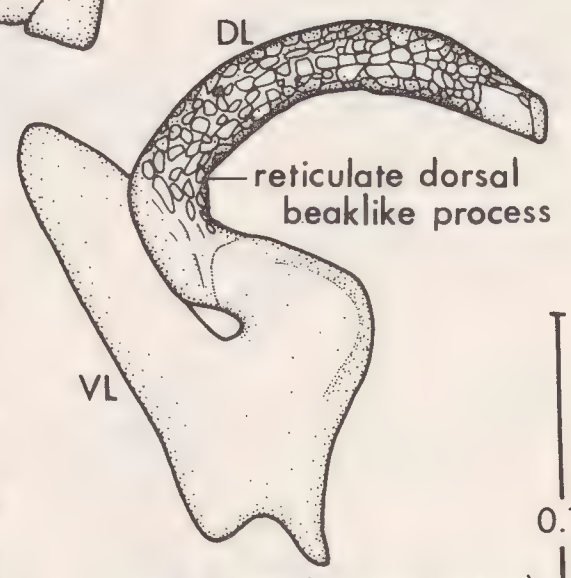
C. Chang

Fig. 2

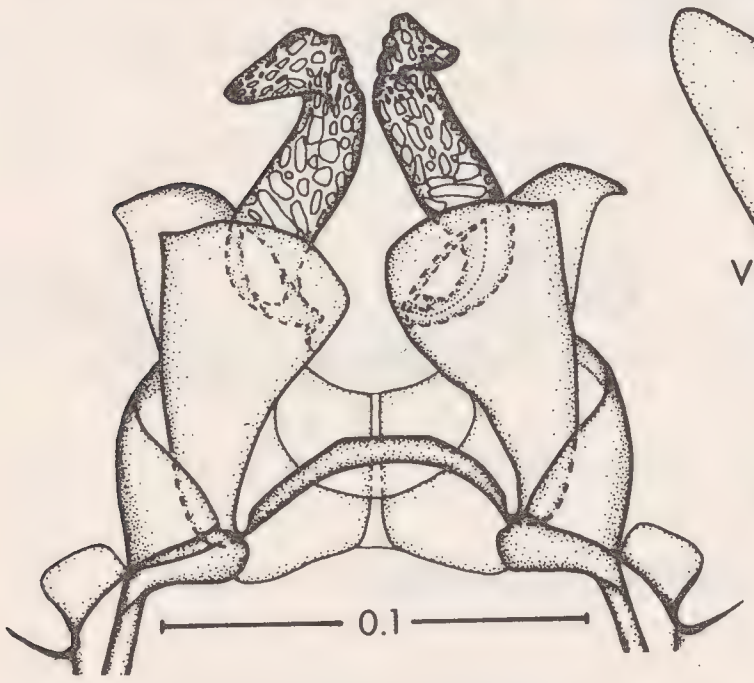


♀ cibarial armature





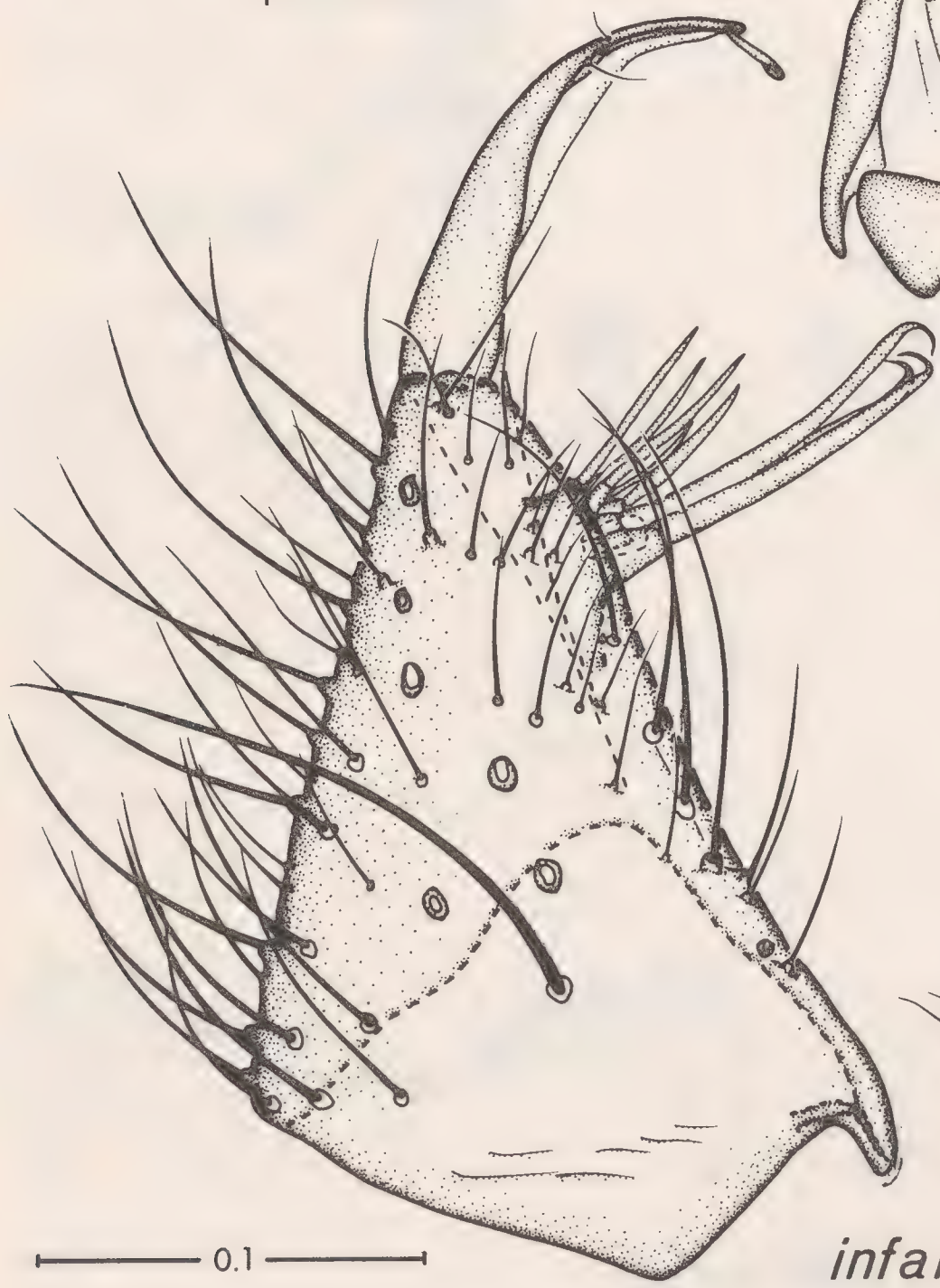
phallosome (lateral view)

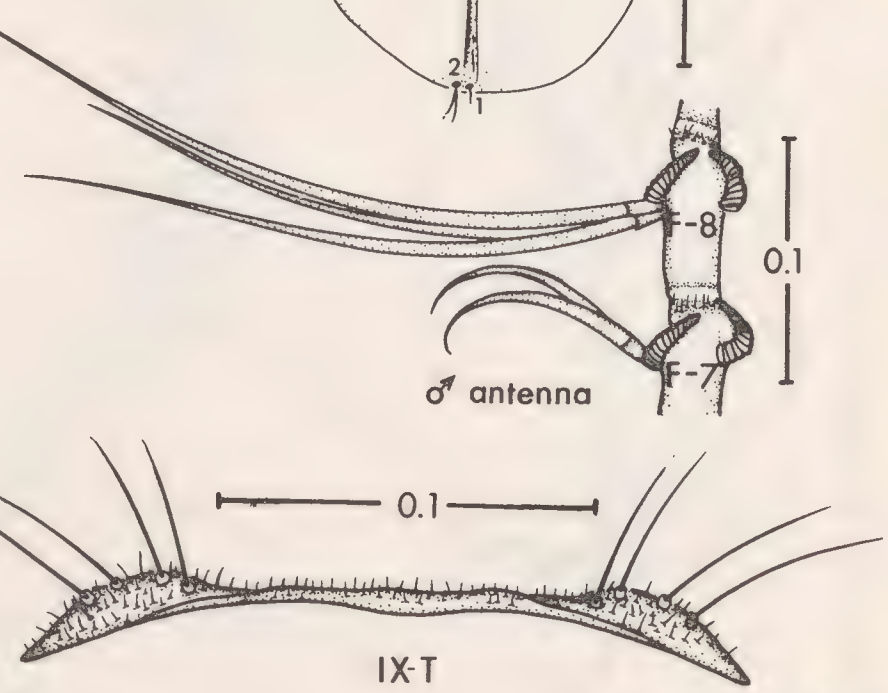


phallosome



proctiger

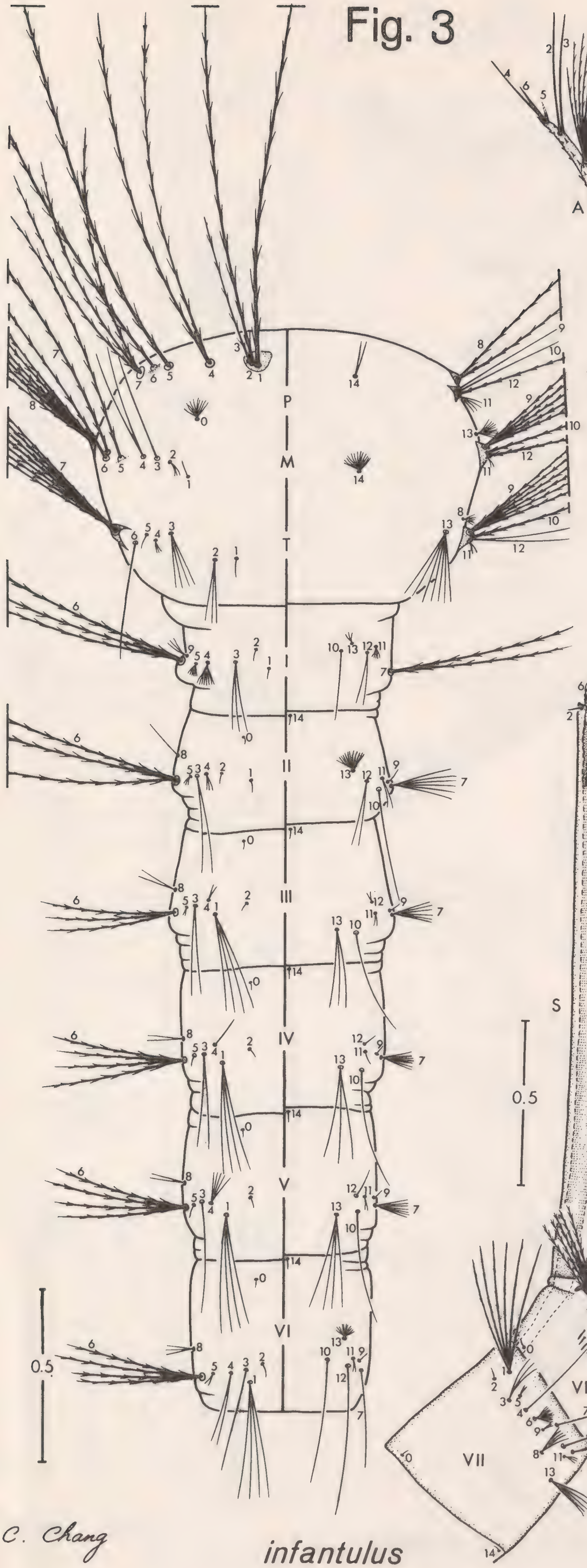


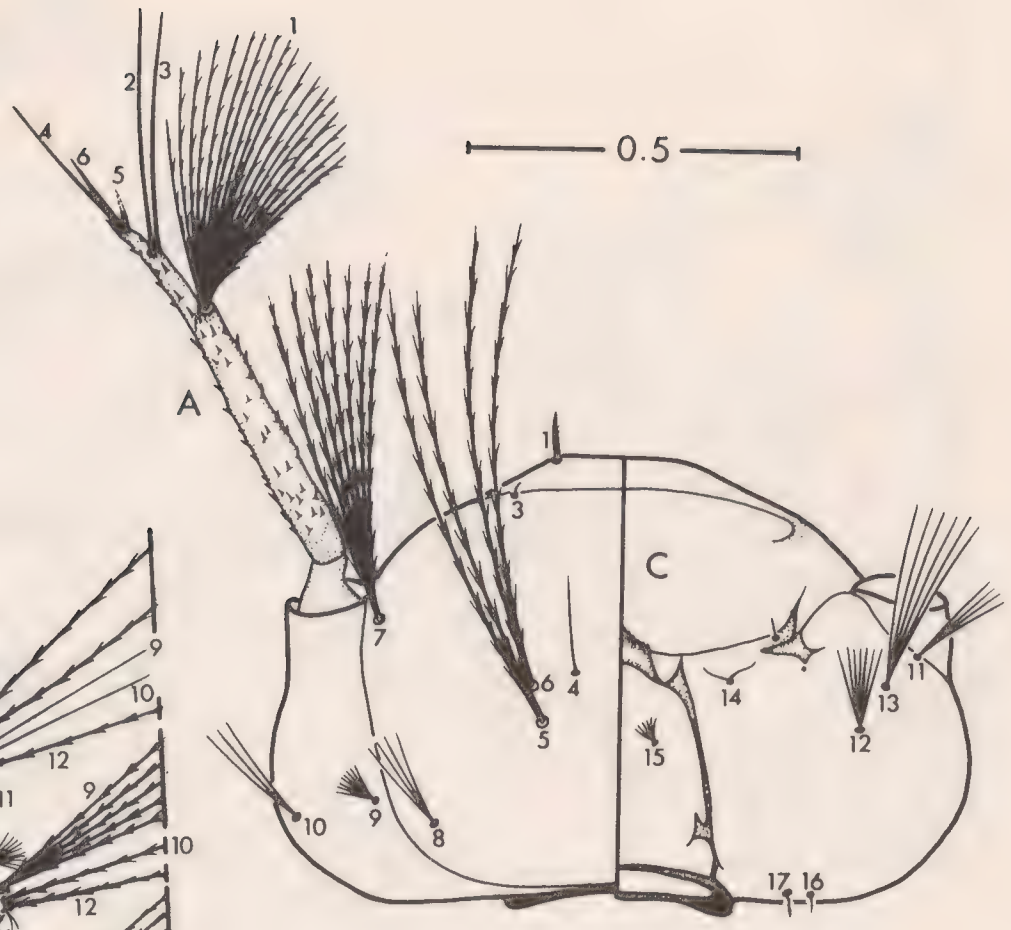


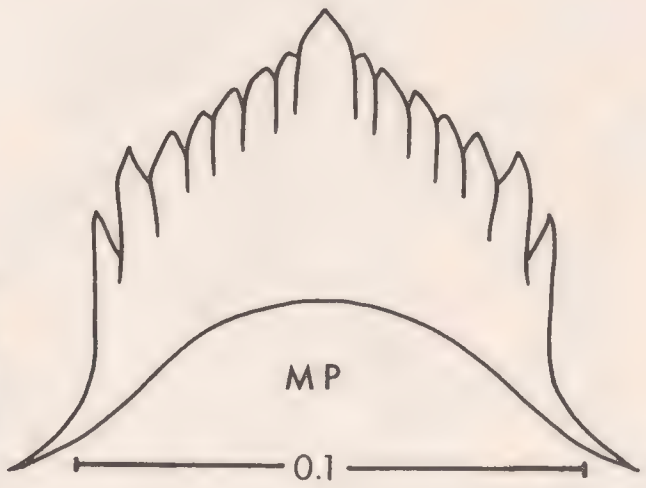
infantulus

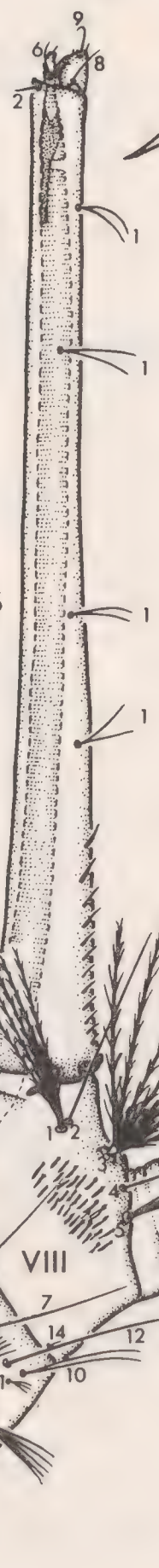
C. Chang

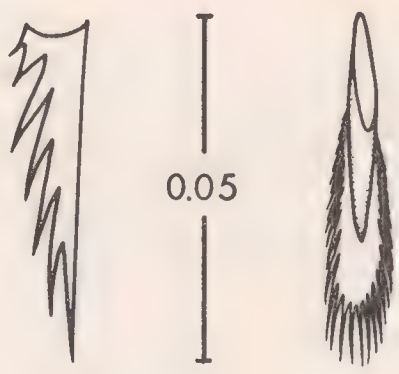
Fig. 3







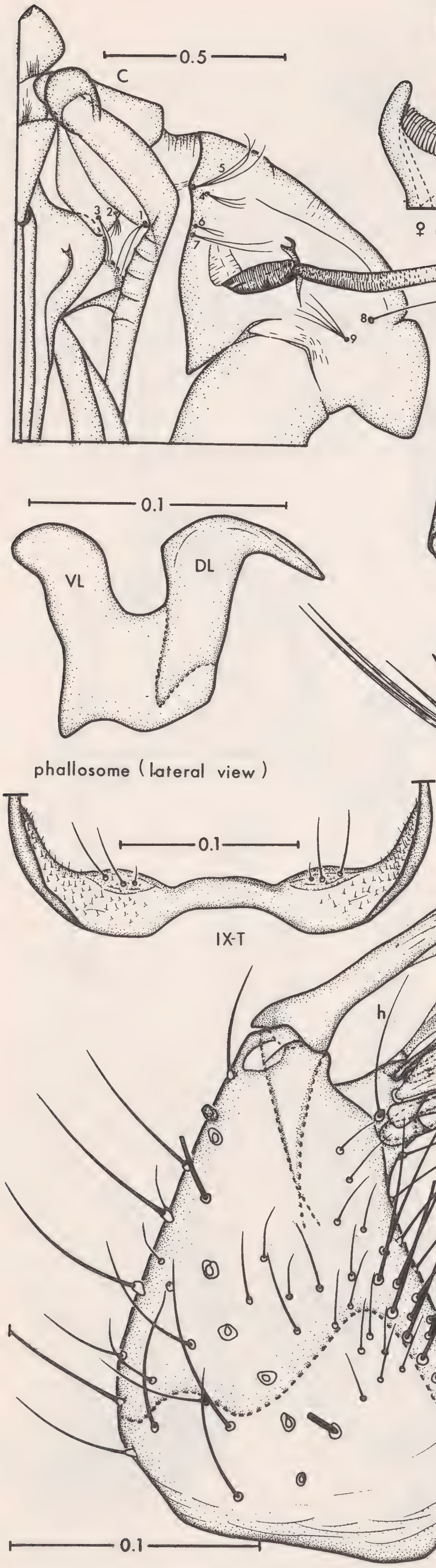


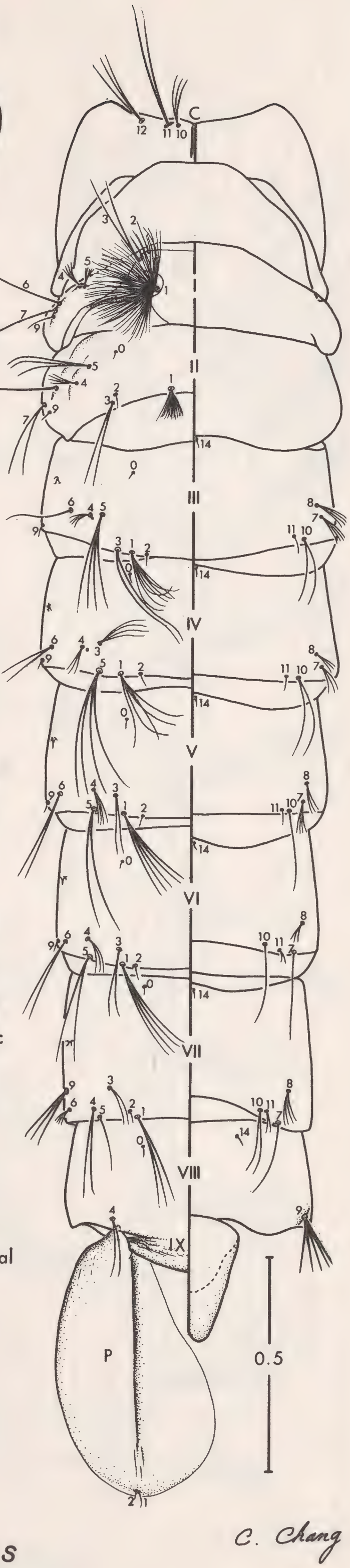


C. Chang

infantulus

Fig. 4


0.5
C
5
3
2
1
6
7
8
9
0.1
VL
DL
phallosome (lateral view)
0.1
IX-T
0.1
F-5
0.1
proctiger
0.05
♀ cibarial armature
g_2
d-f
h
g_1
a
c
b
submarginal setae
0.1
cinctellus


C
12
11
10
II
III
IV
V
VI
VII
VIII
IX
P
14
0.5

C. Chang

Fig. 5

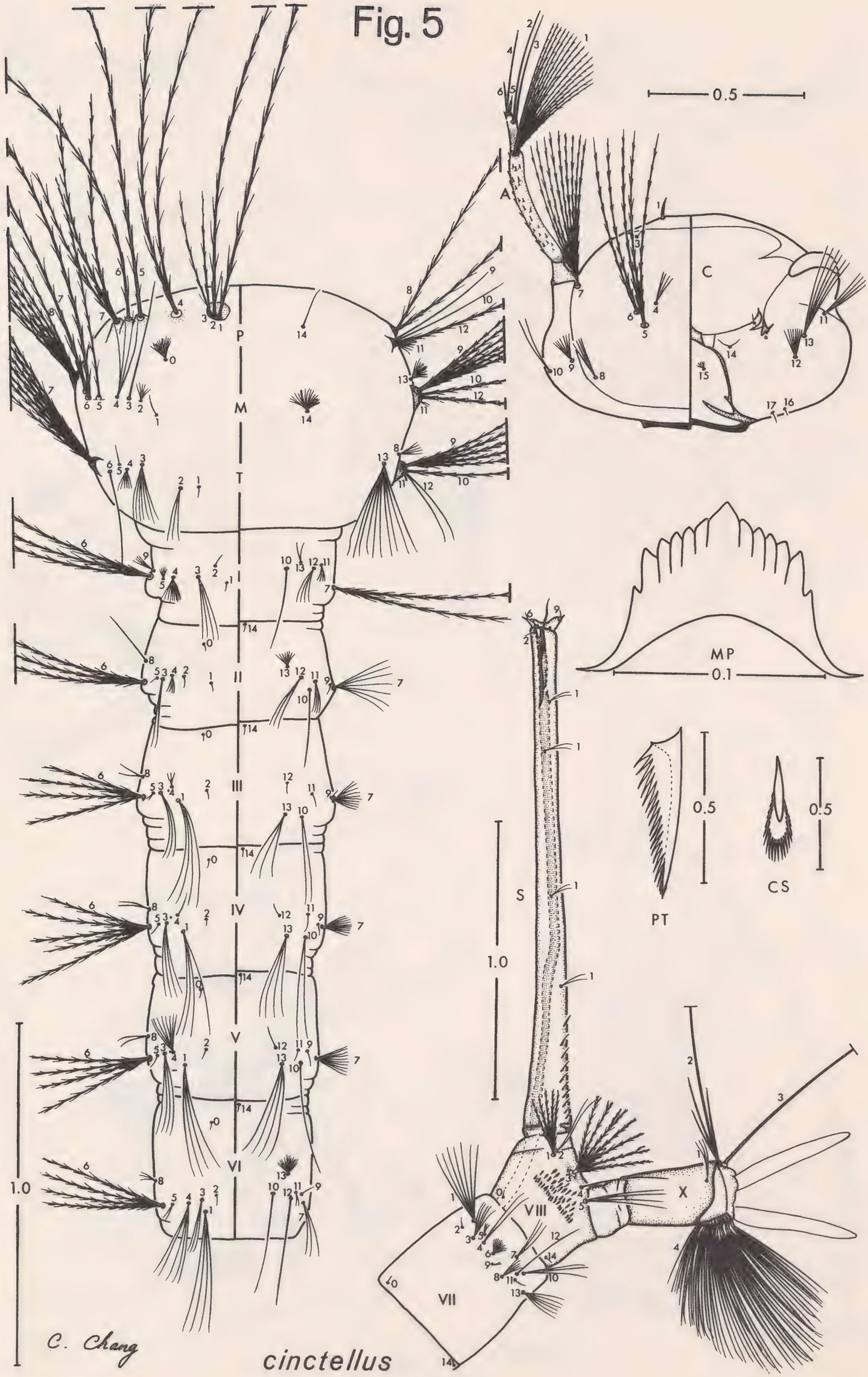
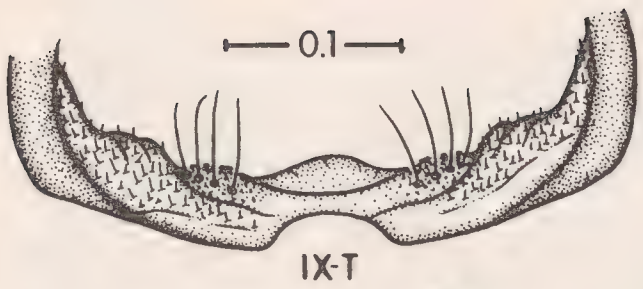
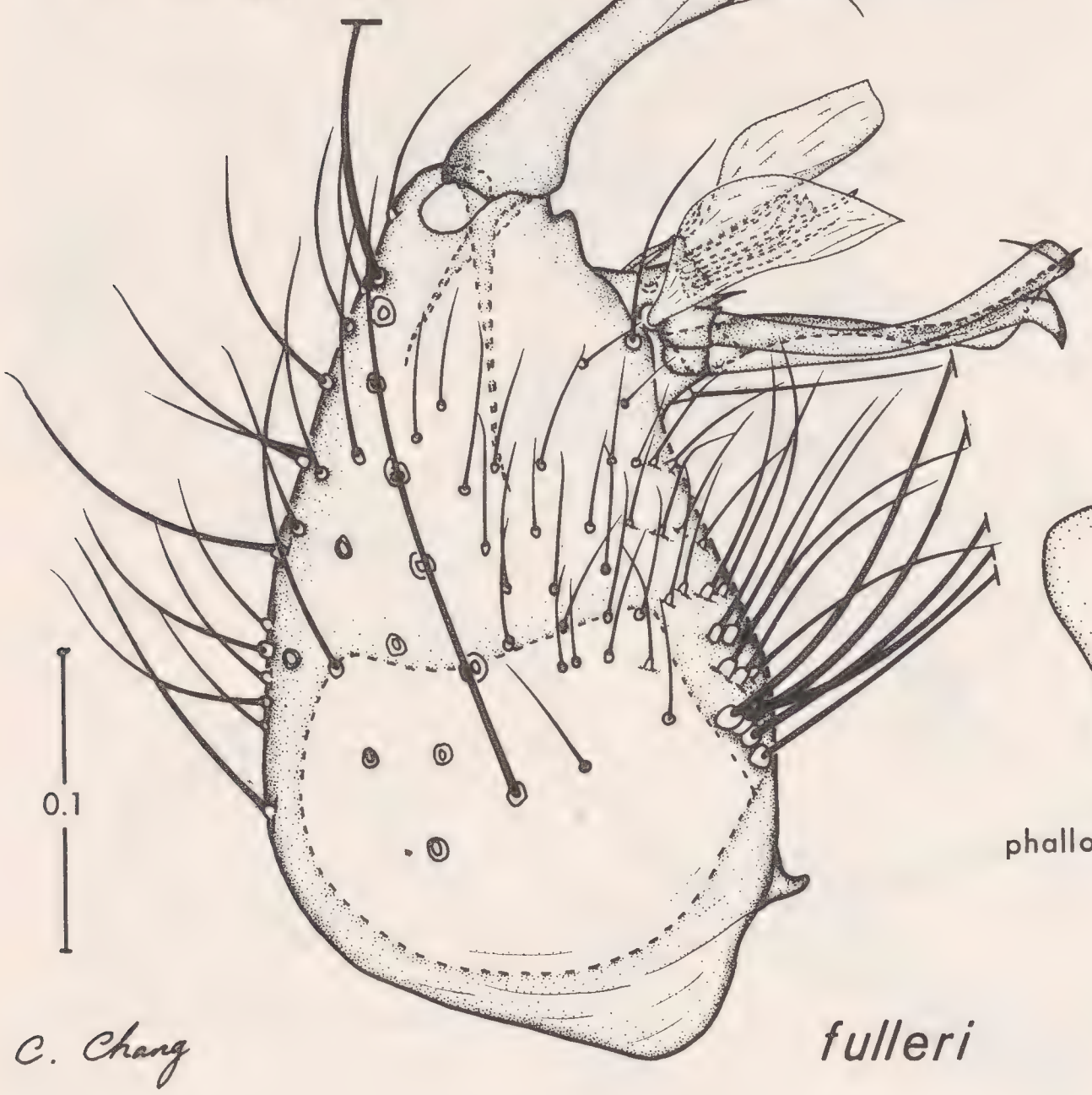

A
C
P
M
T
I
II
III
IV
V
VI
VII
VIII
X
S
MP
PT
CS
0.5
1.0
C. Chang
cinctellus

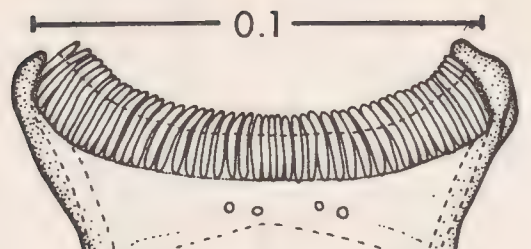
Fig. 6





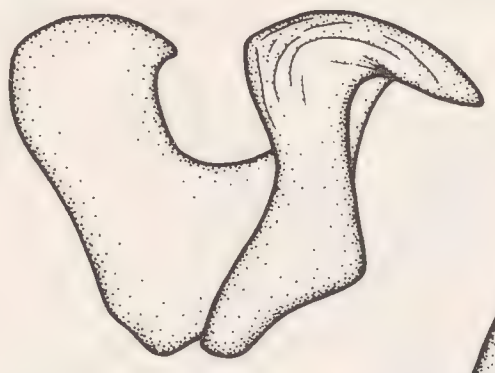
C. Chang

fulleri

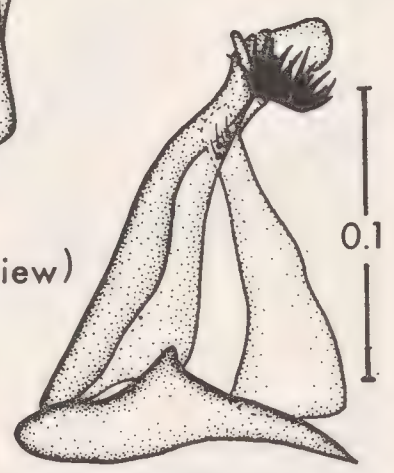


♀ cibarial armature





phallosome (lateral view)



proctiger

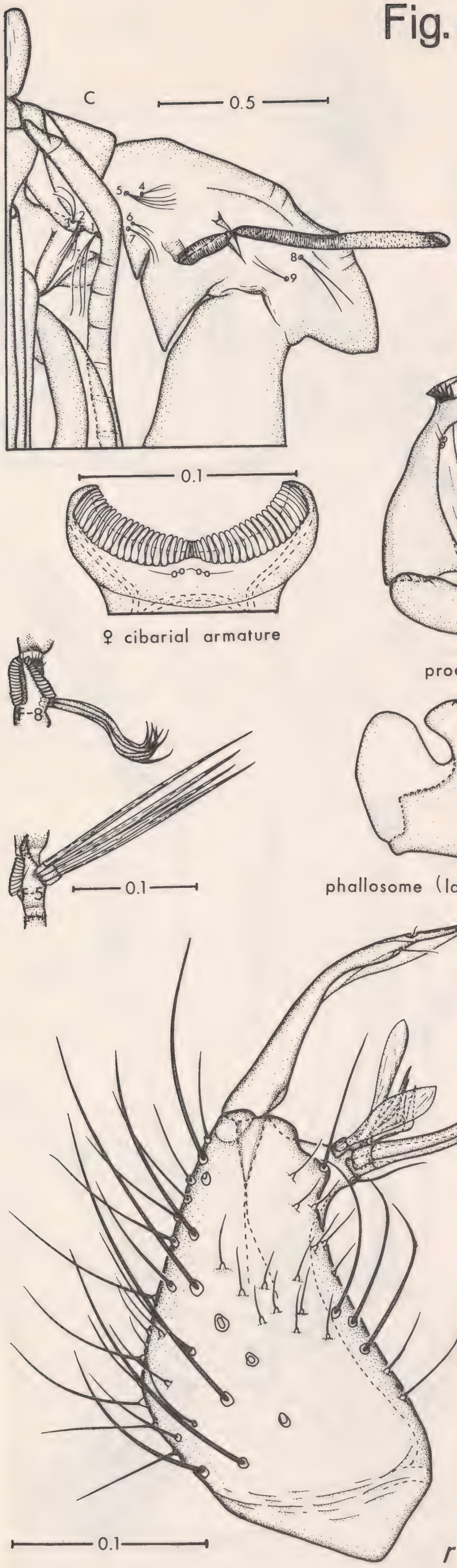
proctiger

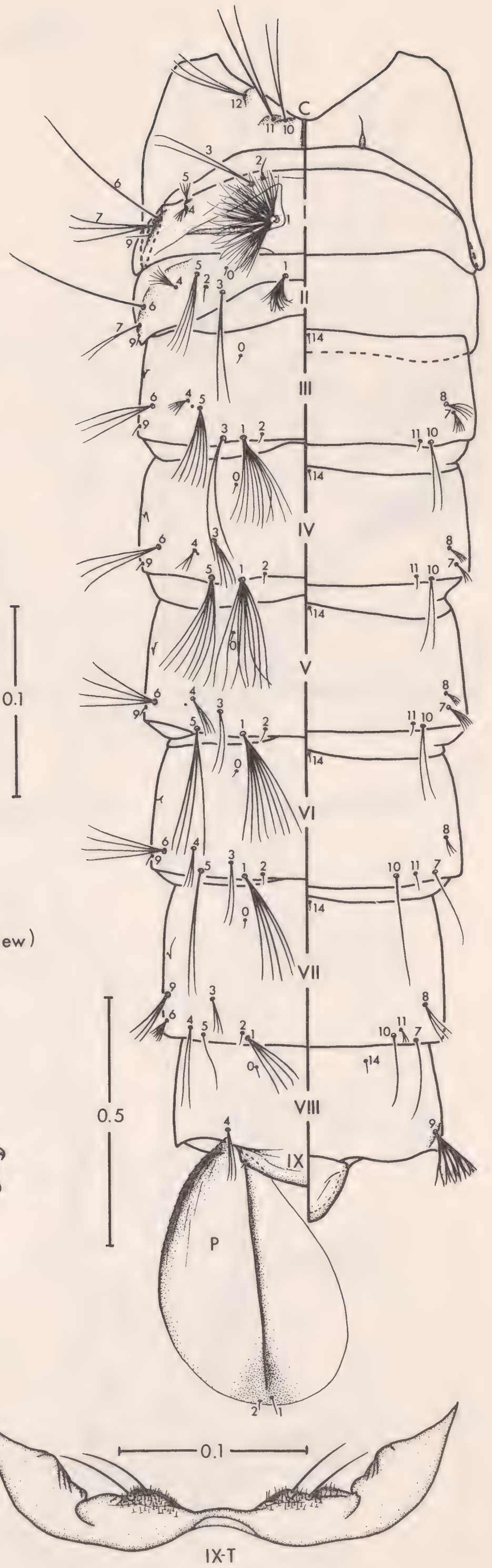
phallosome (lateral view)

♂ antenna

seniori

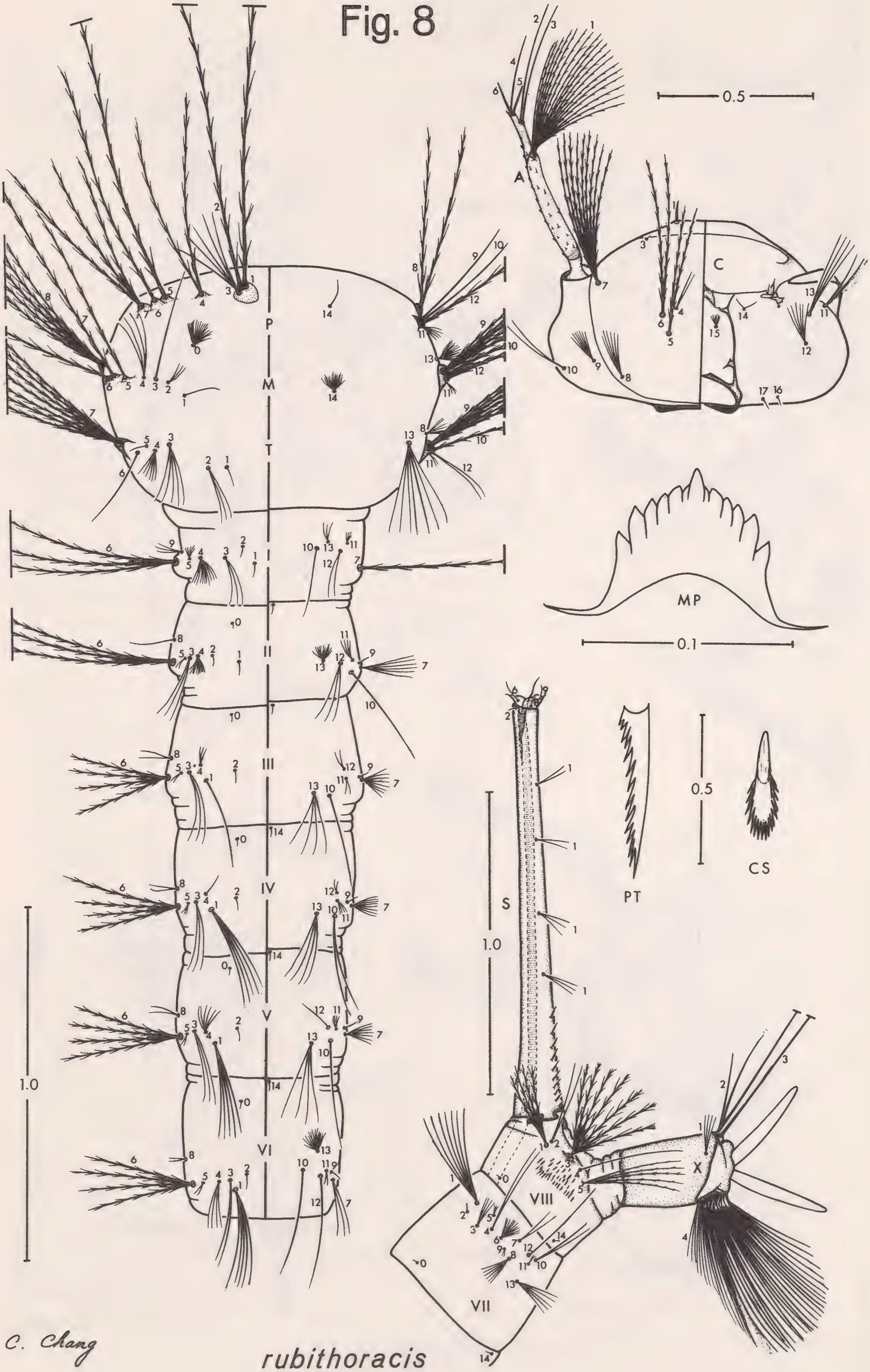
Fig. 7


C
0.5
0.1
♀ cibarial armature
proctiger
0.1
phallosome (lateral view)
0.1
0.1
rubithoracis


C
III
IV
V
VI
VII
VIII
IX
P
0.5
0.1
IX-T

C. Chang

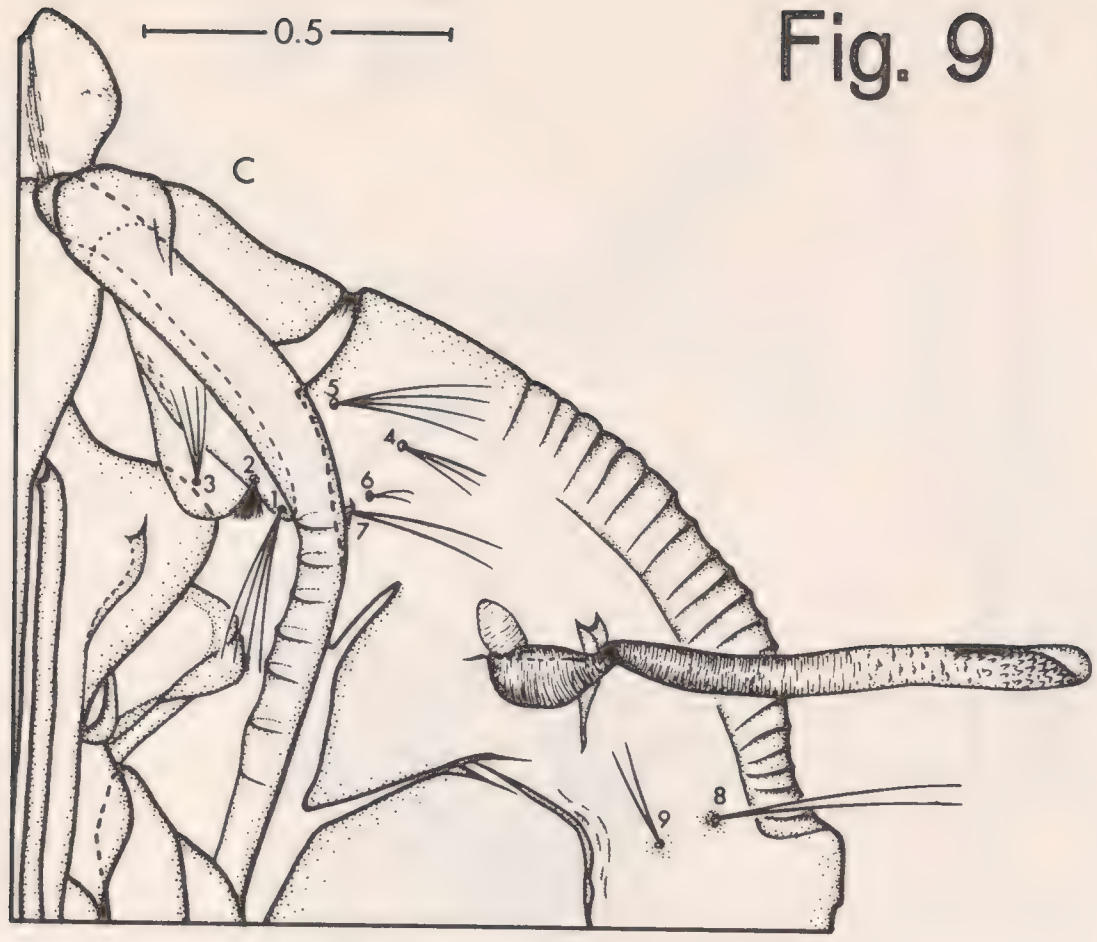
Fig. 8

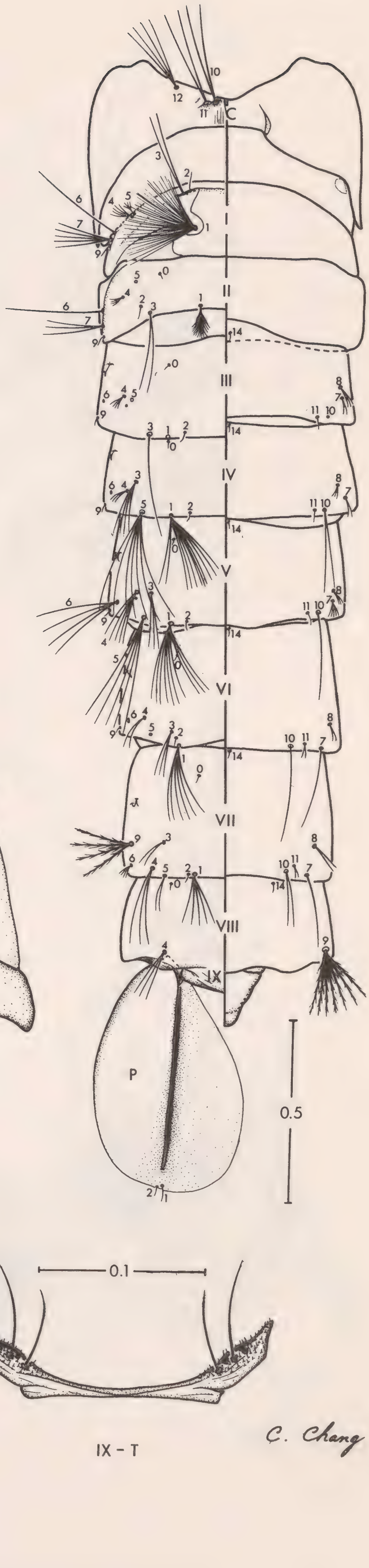


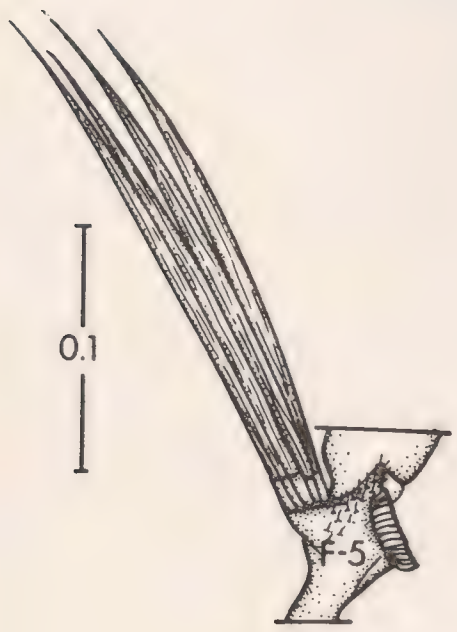
C. Chang

rubithoracis

Fig. 9





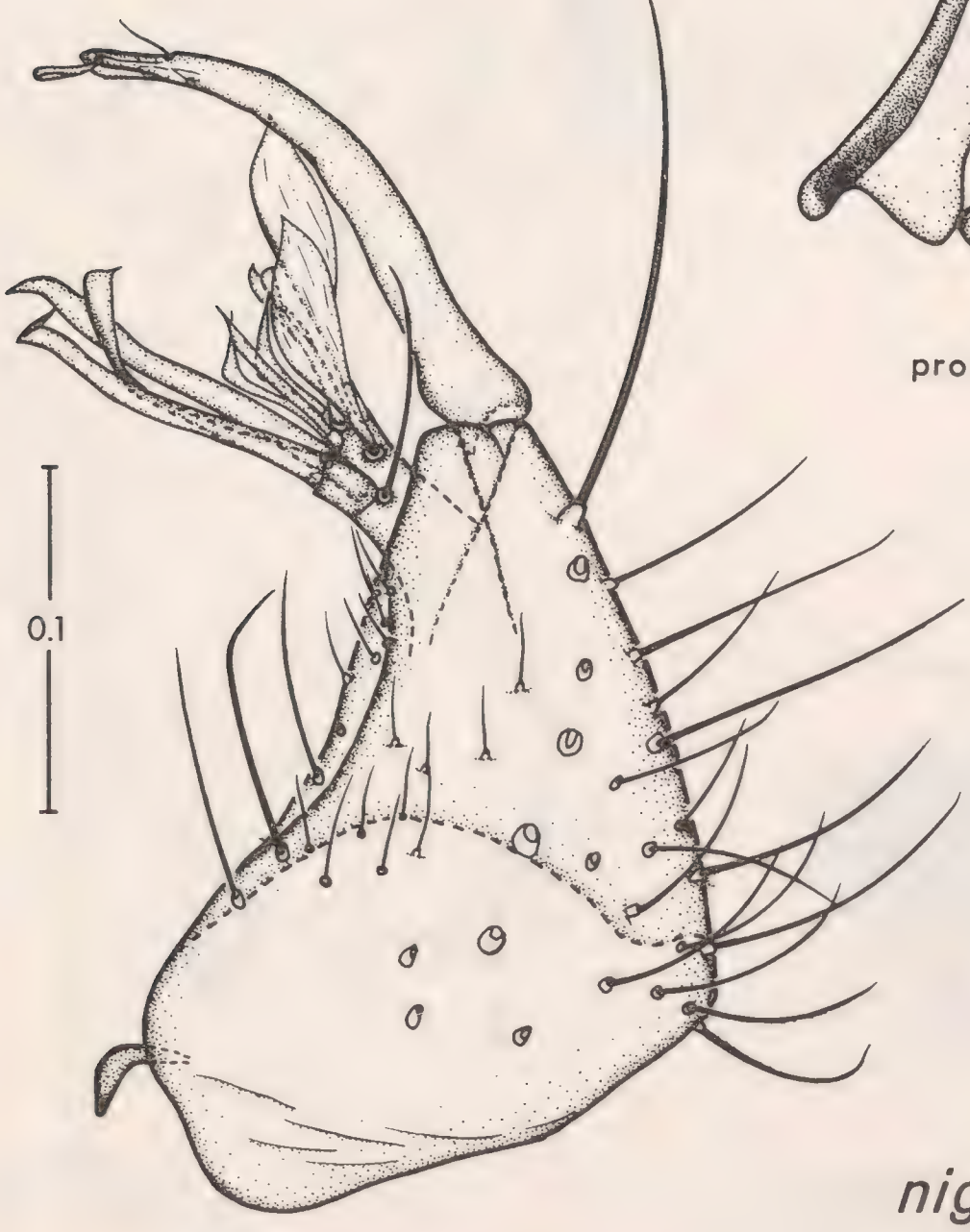




phallosome (lateral view)



proctiger

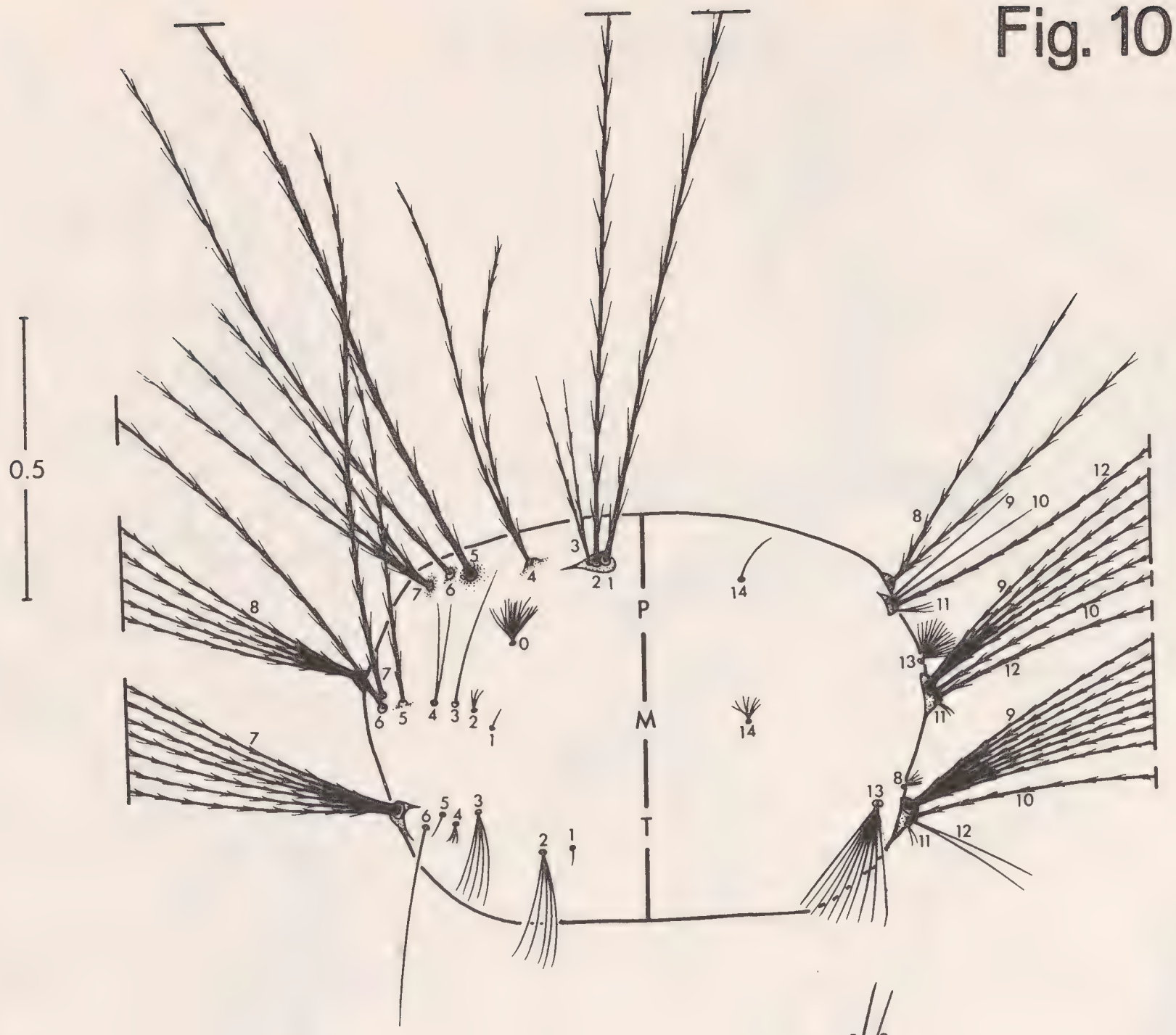


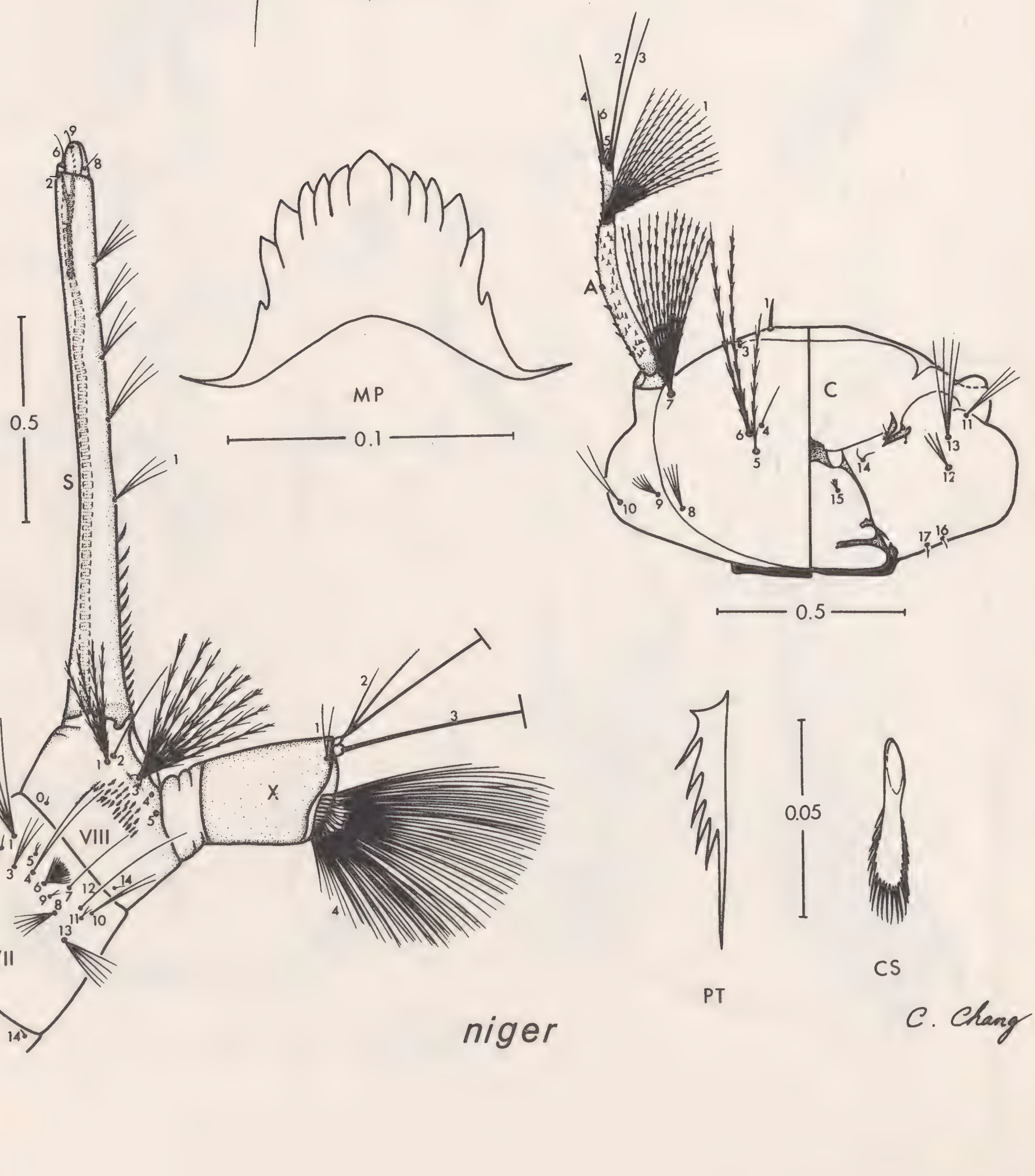
niger

IX - T

C. Chang

Fig. 10

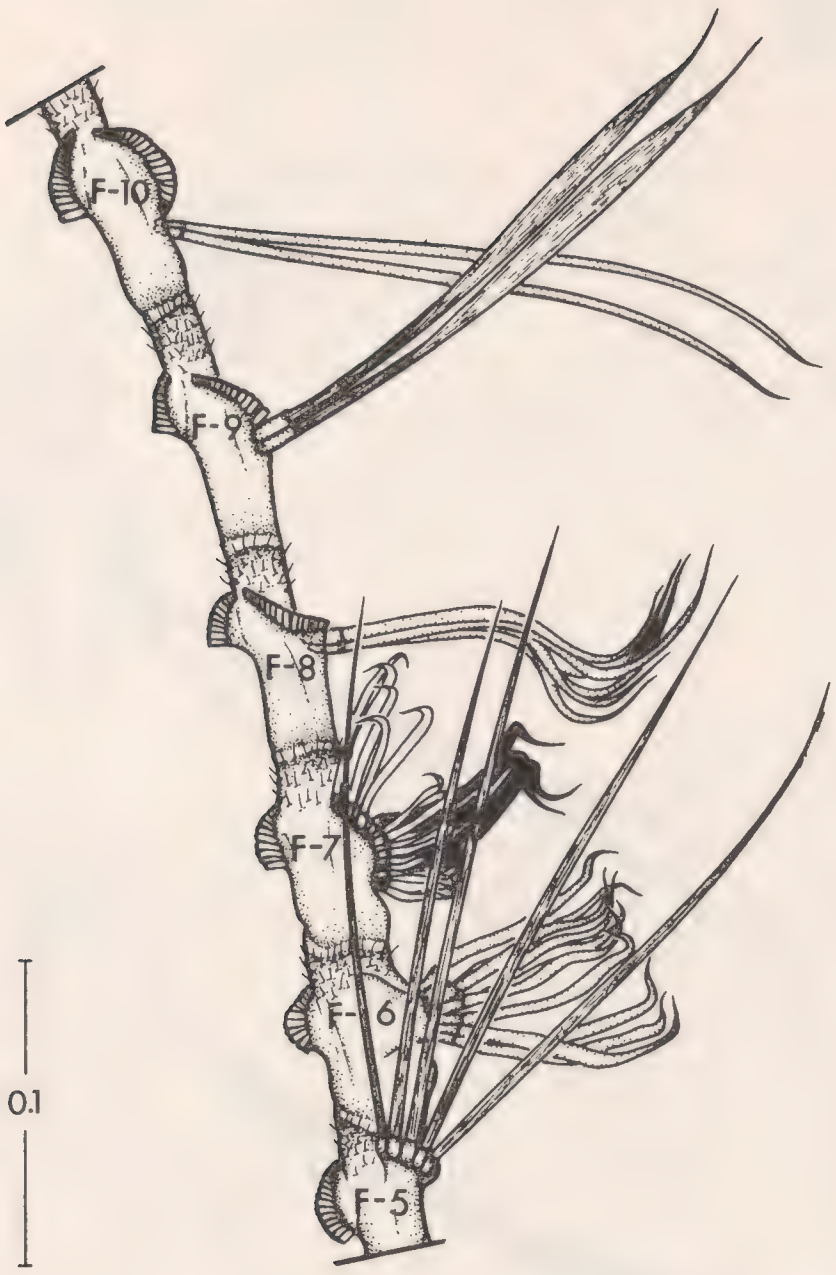




niger

C. Chang

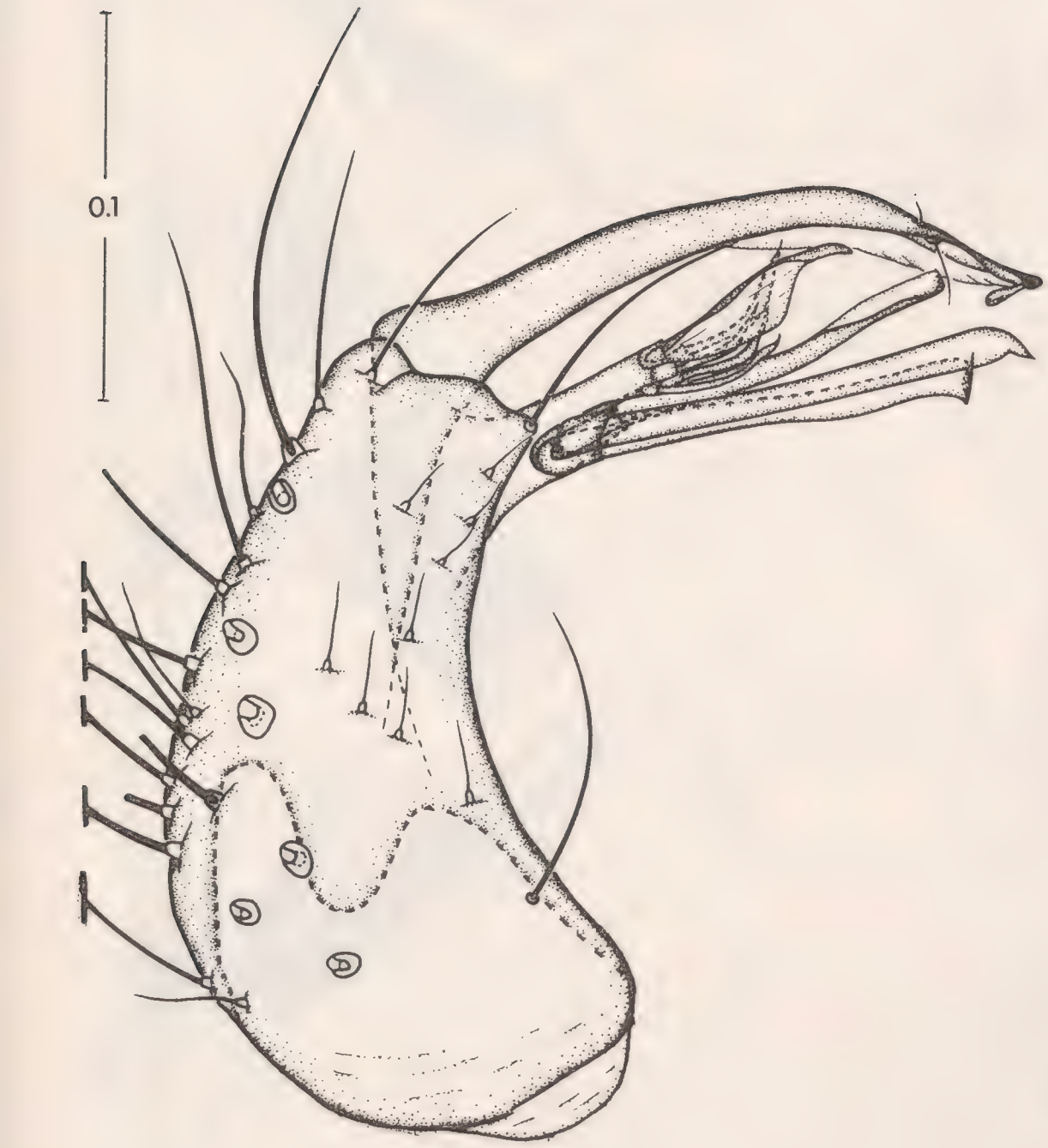
Fig. 11

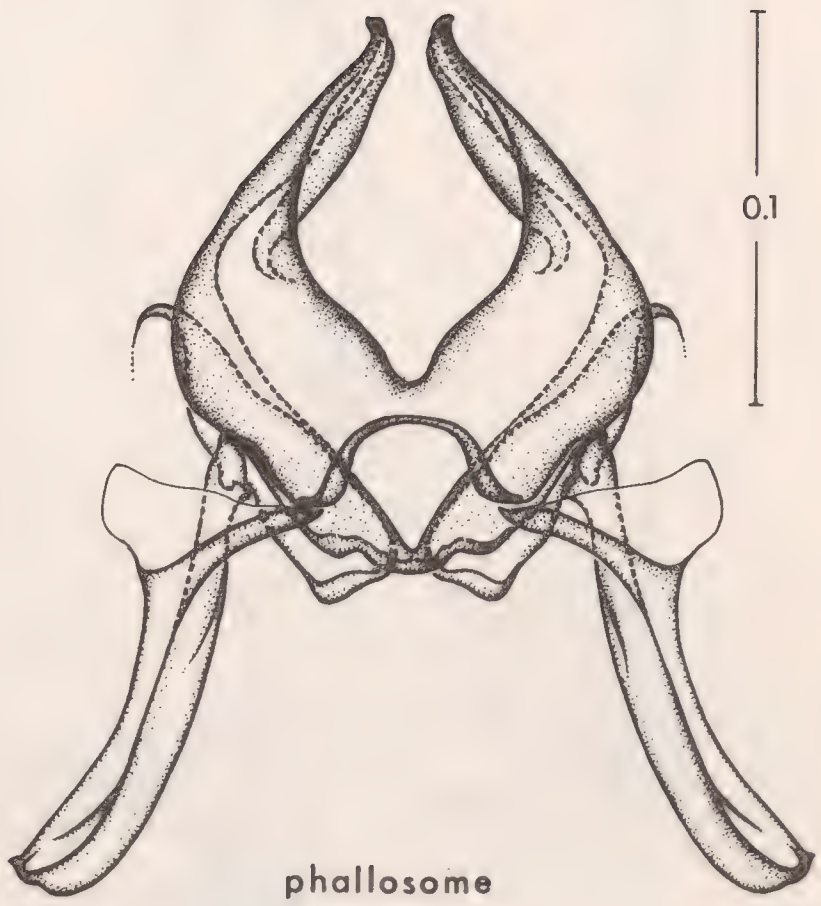


♂ antenna



proctiger





phallosome

C. Chang

gibbulus

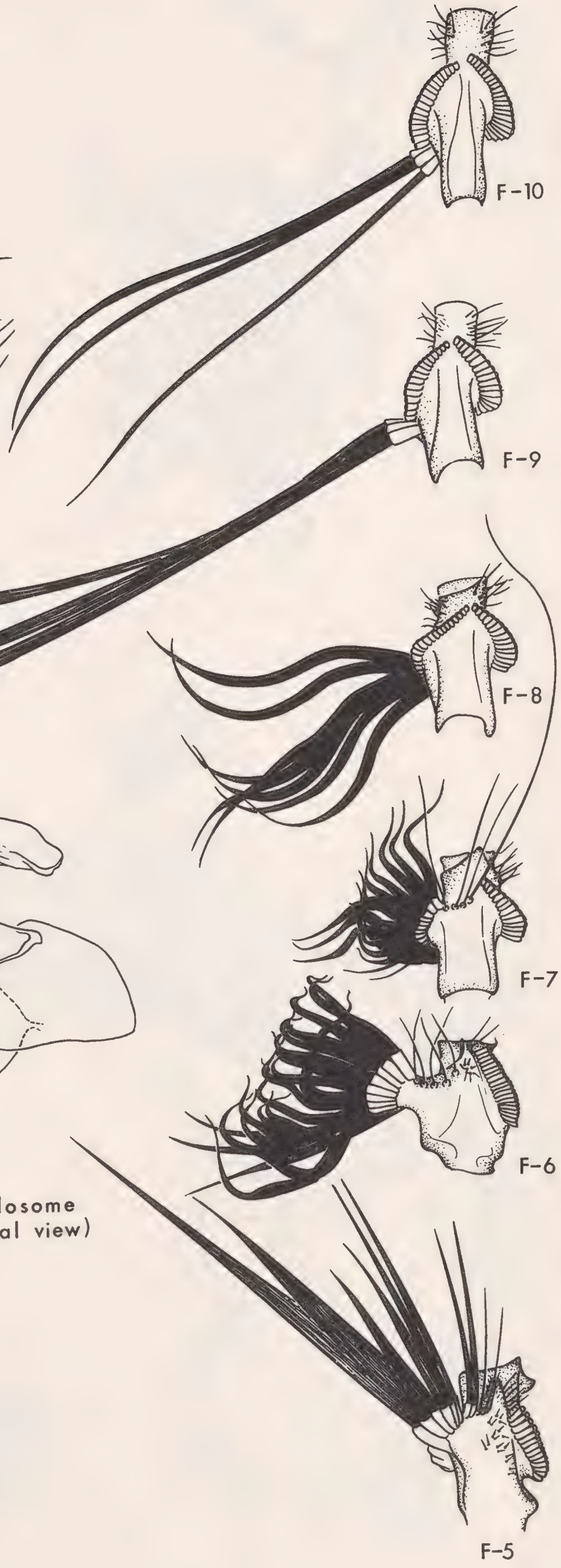
Fig. 12



proctiger

phallosome
(lateral view)

IX-T



F-10

F-9

F-8

F-7

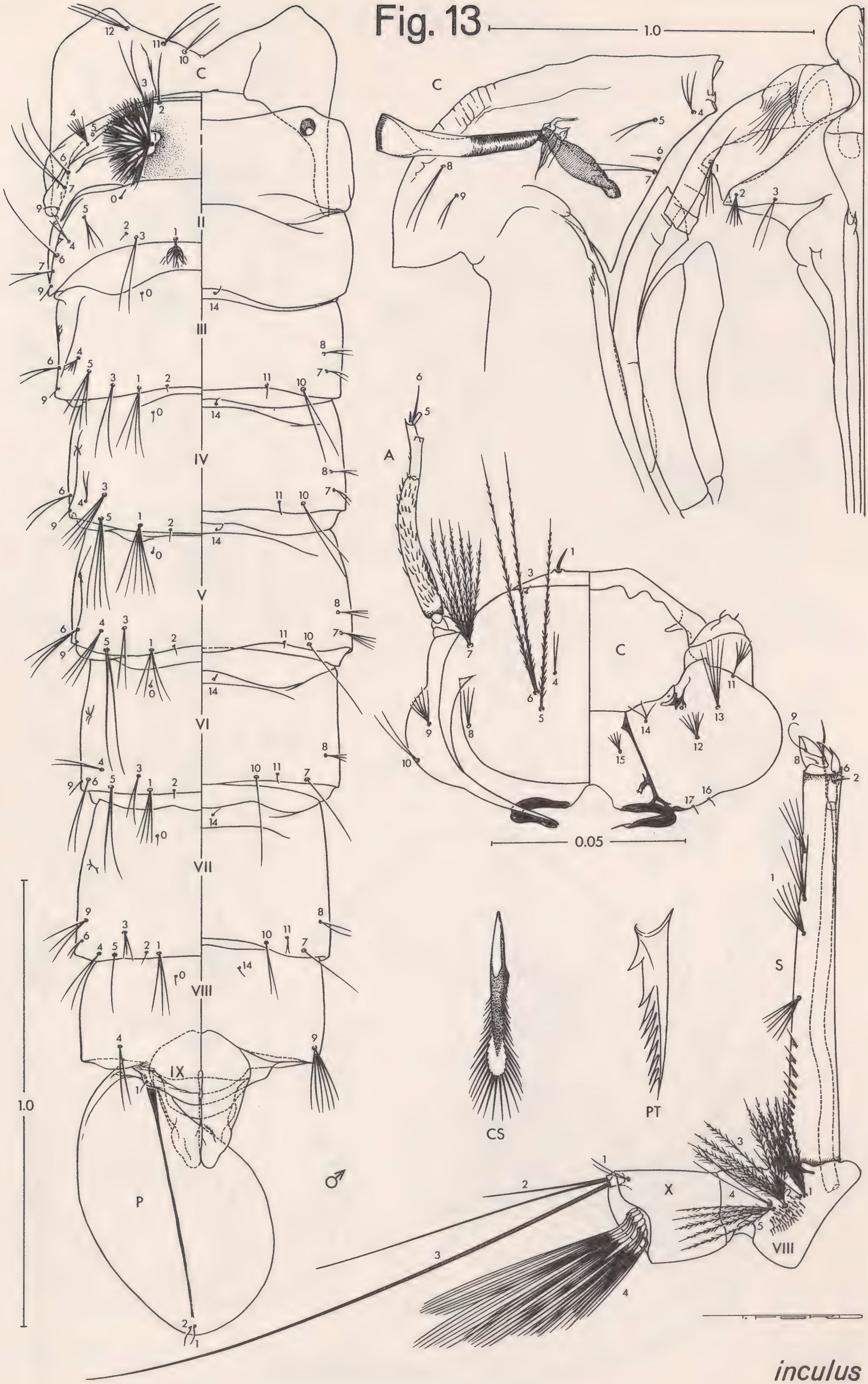
F-6

F-5

♂ antenna

inculus

Fig. 13



inculus

Fig. 14

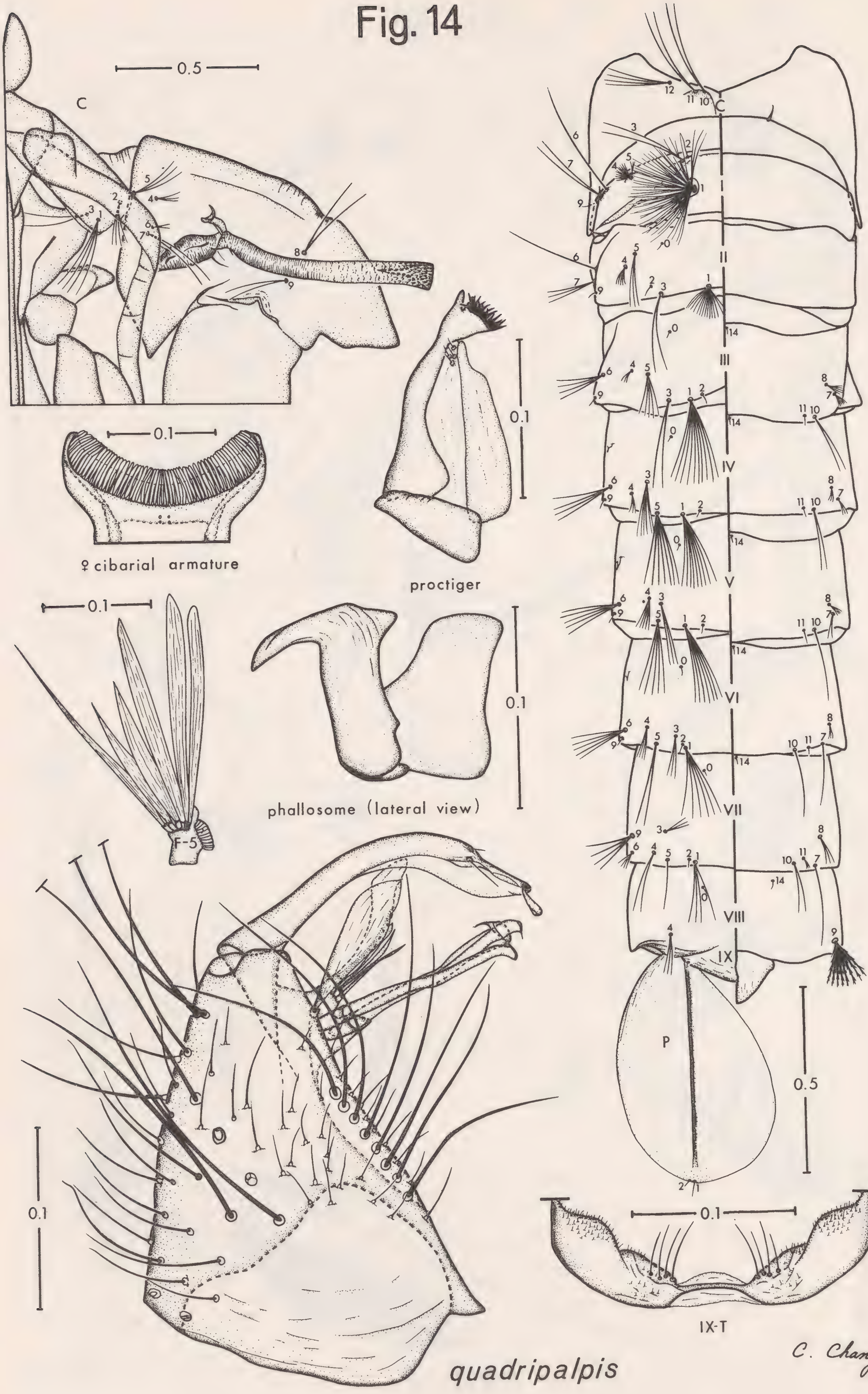
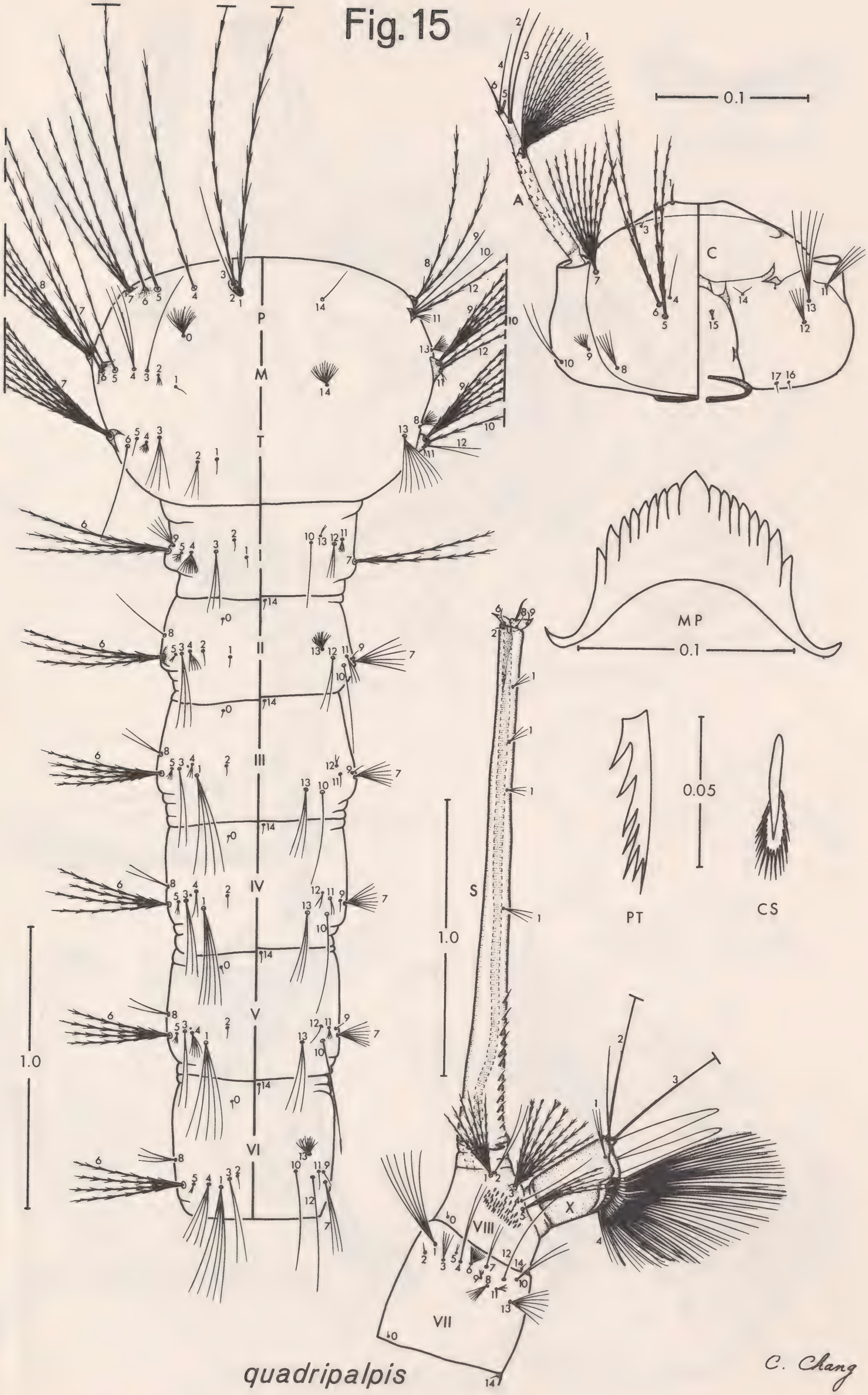

0.5
C
0.1
♀ cibarial armature
0.1
proctiger
0.1
phallosome (lateral view)
F-5
0.1
C
III
IV
V
VI
VII
VIII
IX
P
0.5
0.1
IX-T
quadripalpis
C. Chang

Fig. 15



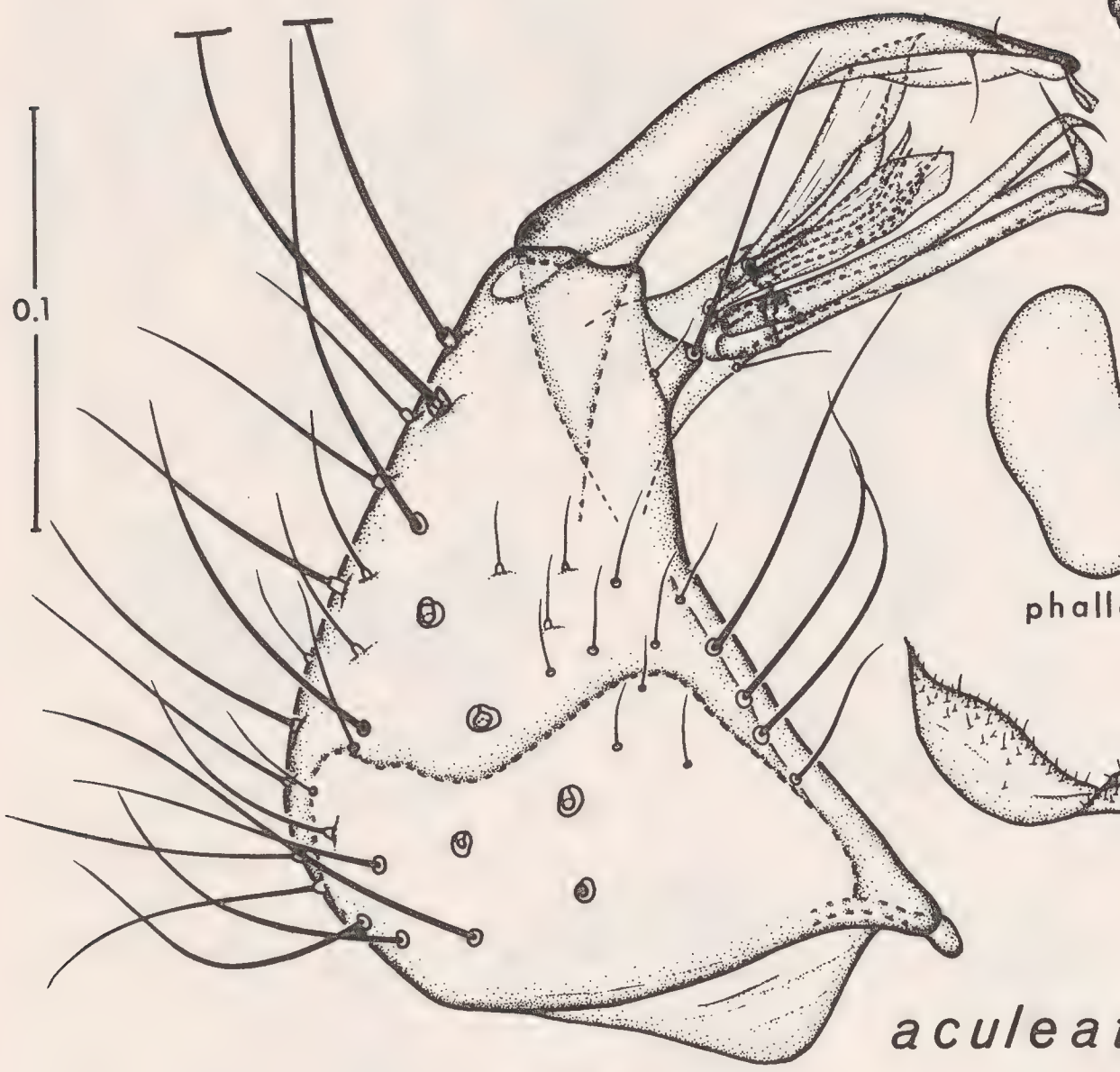
quadripalpis

C. Chang

Fig. 16



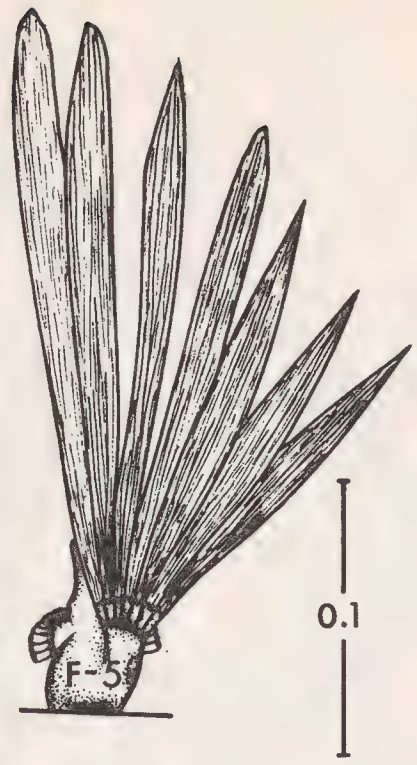
♀ cibarial armature



aculeatus

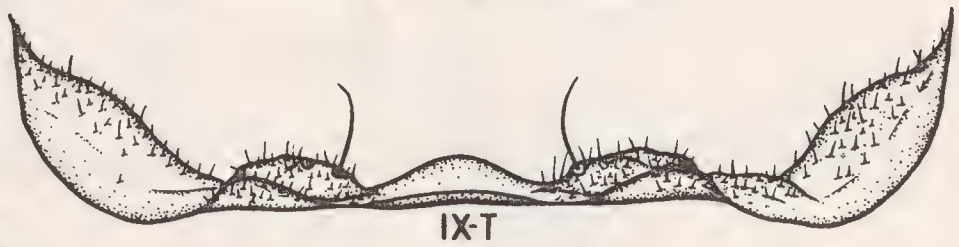


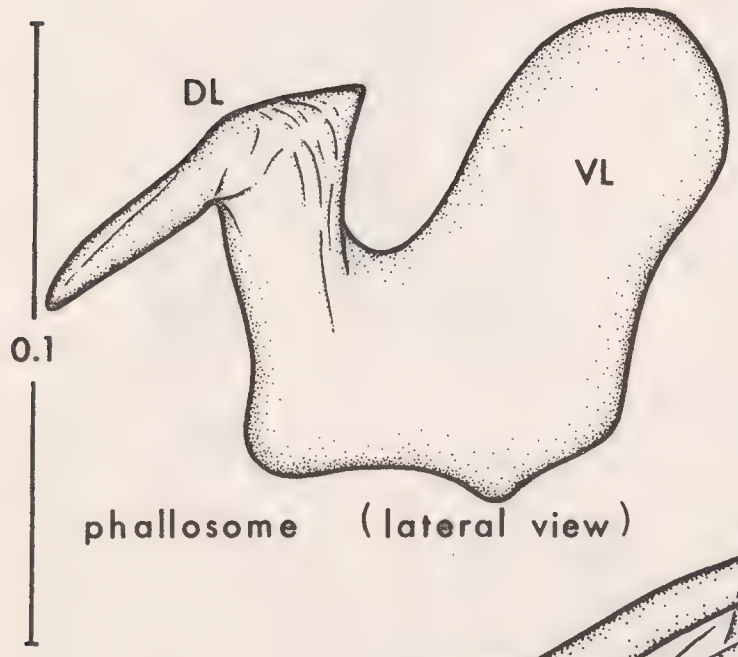
proctiger



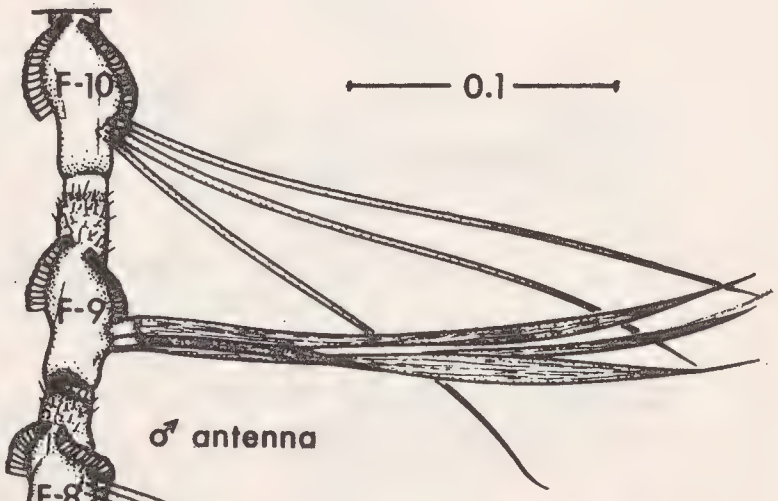


phallosome (lateral view)

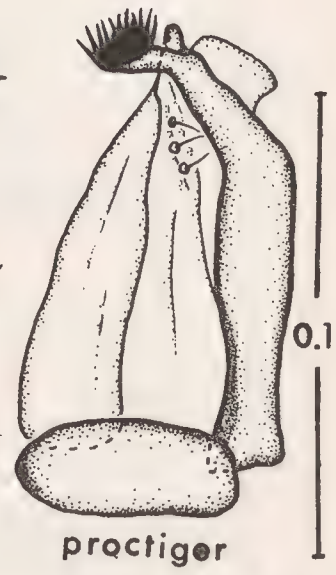




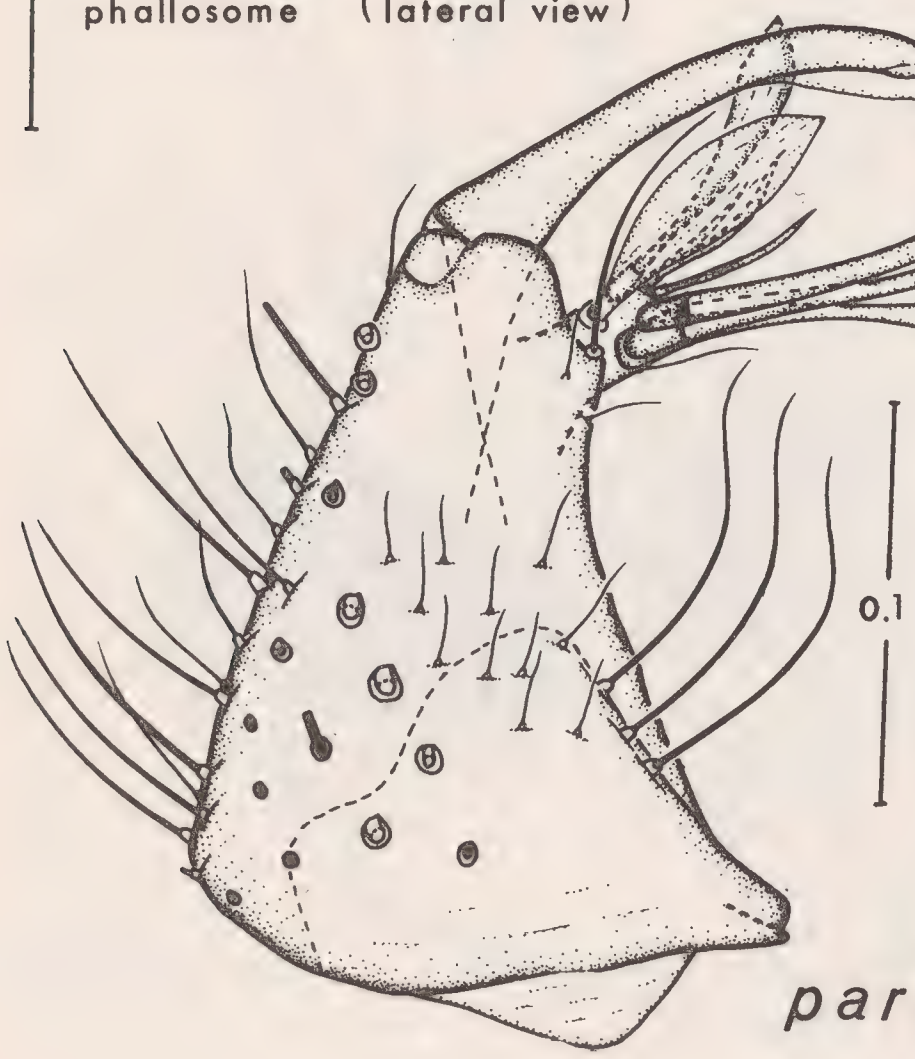
phallosome (lateral view)

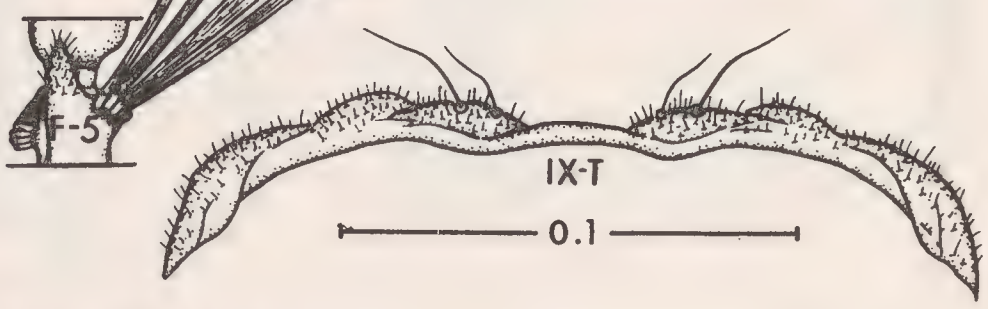


♂ antenna



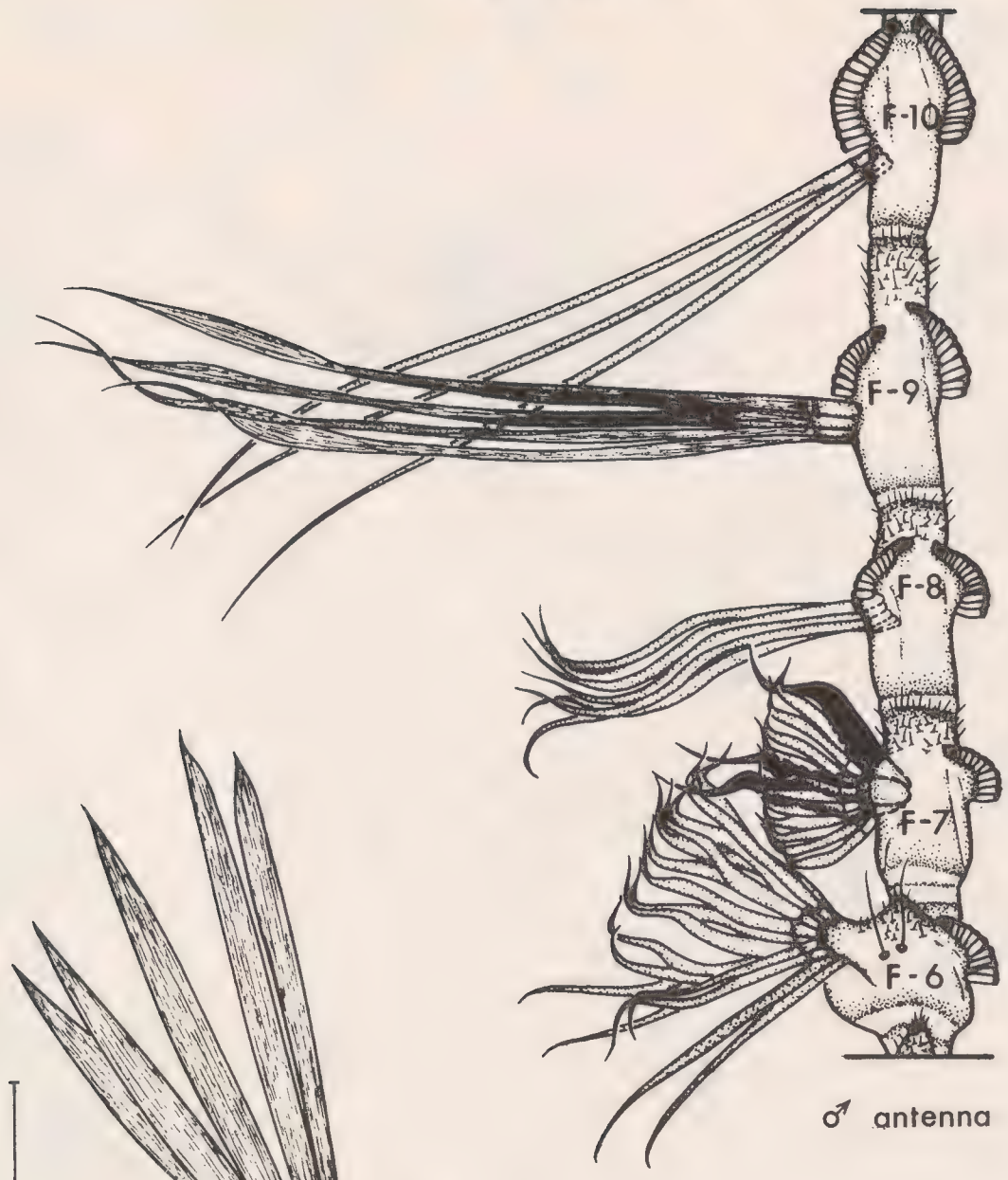
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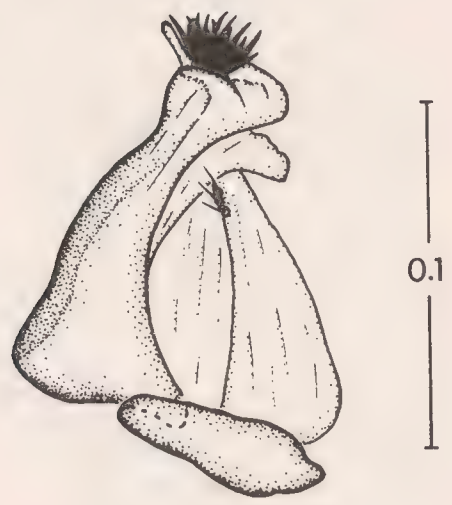


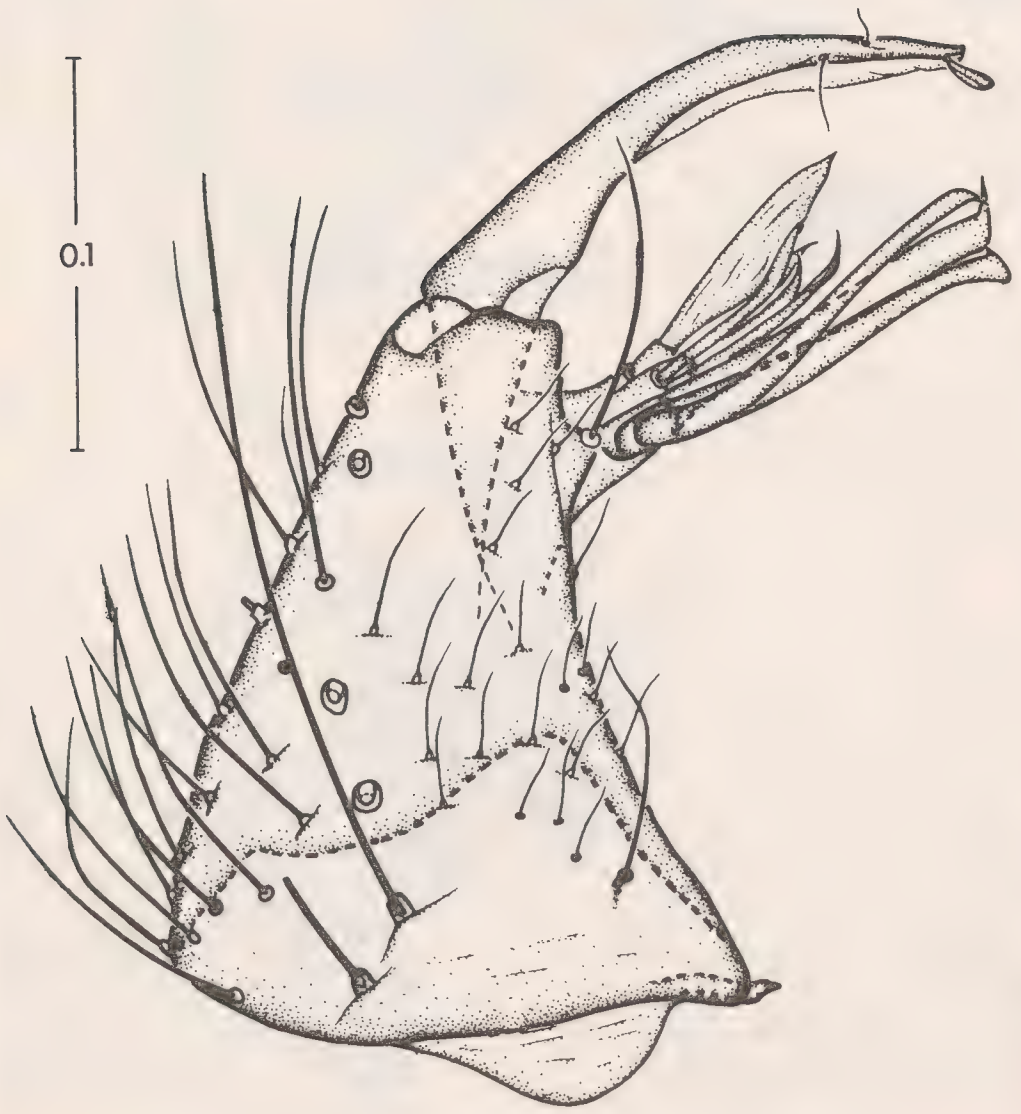


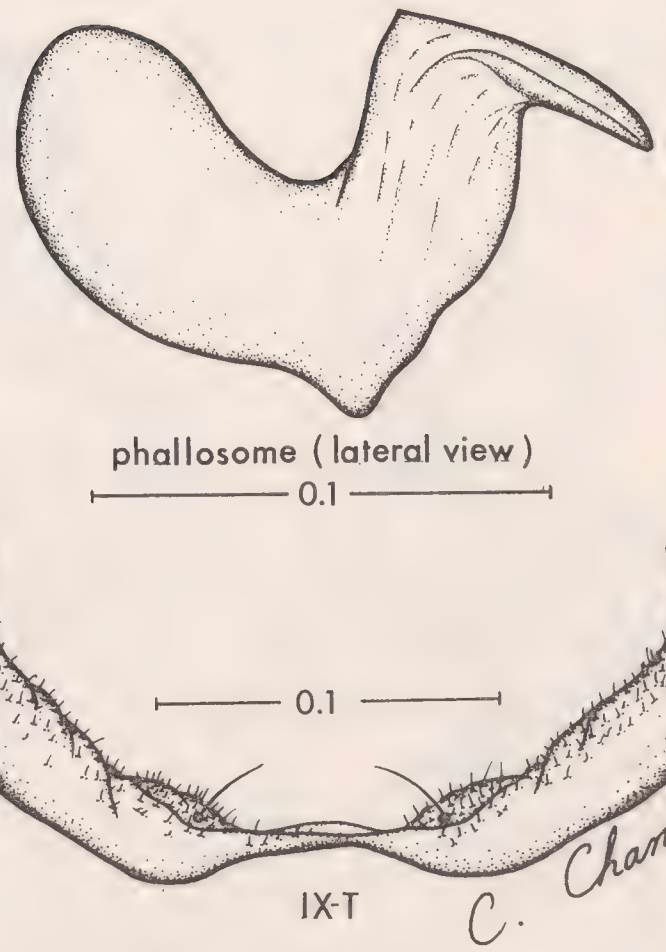
paraculeatus

Fig. 17









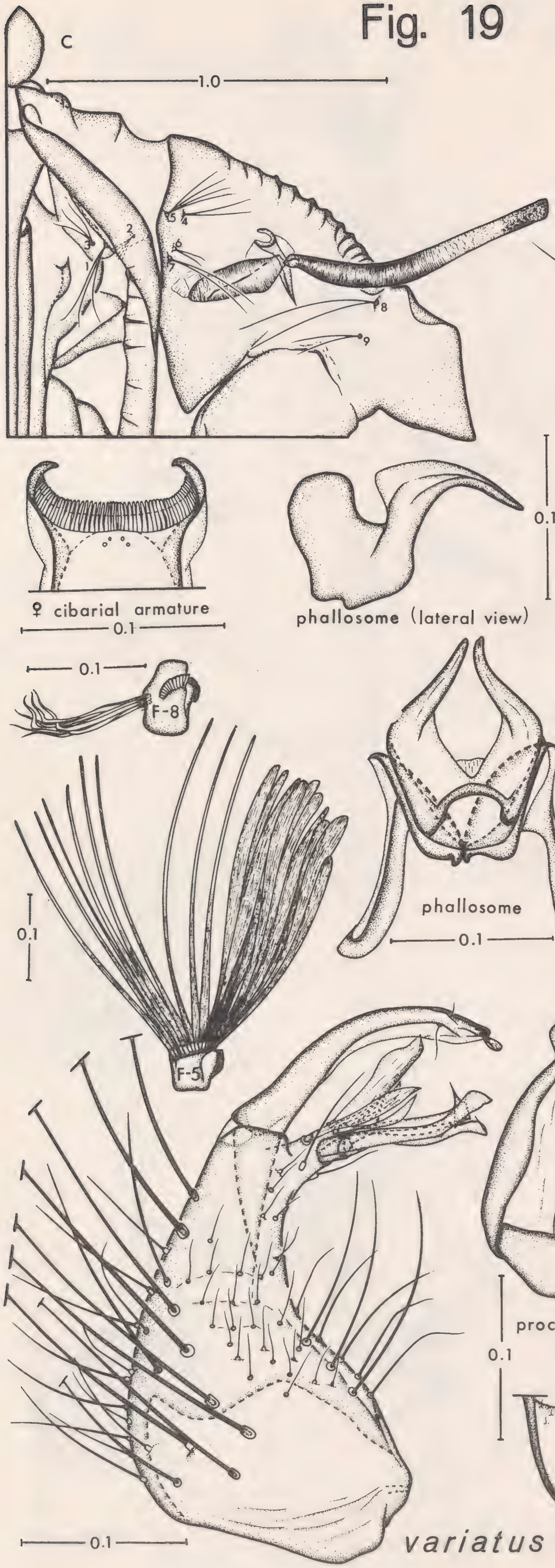
aestivus

Fig.18

reidi

A
C
P
PT
S
MP
CS
VIII
X
F-10
F-9
F-8
F-7
F-6
F-5
♂ antenna
phallosome
(lateral view)
1.0
0.1
0.1
T. FORD

Fig. 19


C
1.0
♀ cibarial armature
0.1
phallosome (lateral view)
0.1
F-8
F-5
0.1
phallosome
0.1
proctiger
0.1
variatus

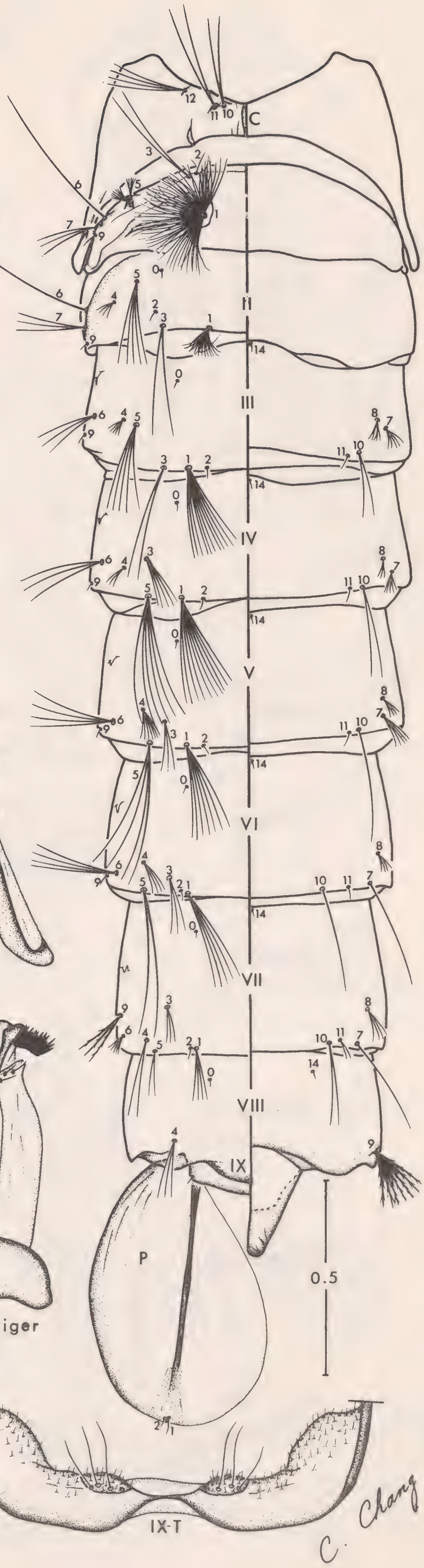
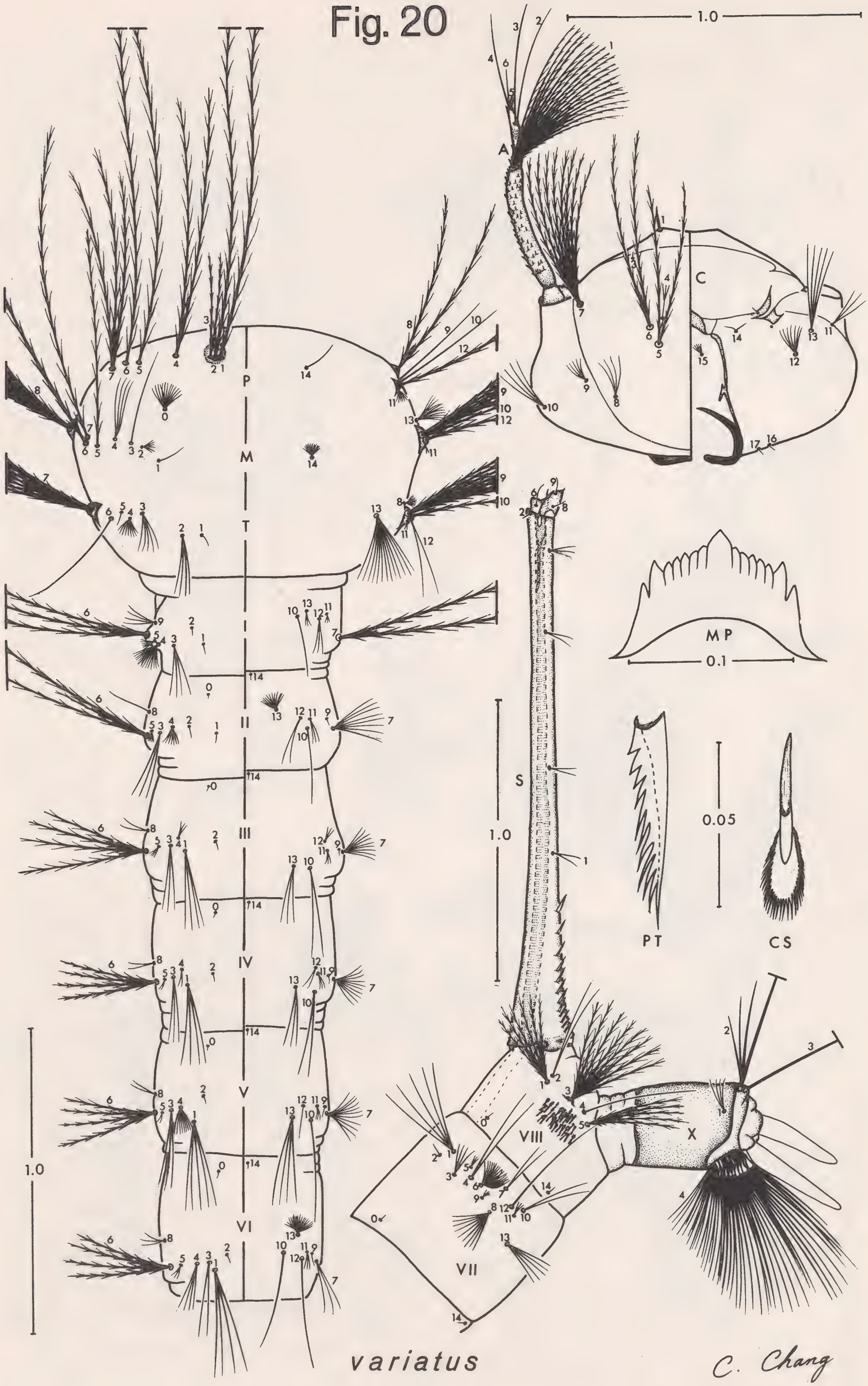

C
II
III
IV
V
VI
VII
VIII
IX
P
0.5
IX-T
C. Chang

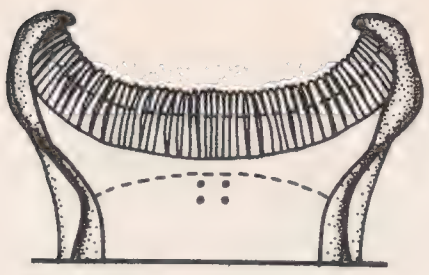
Fig. 20

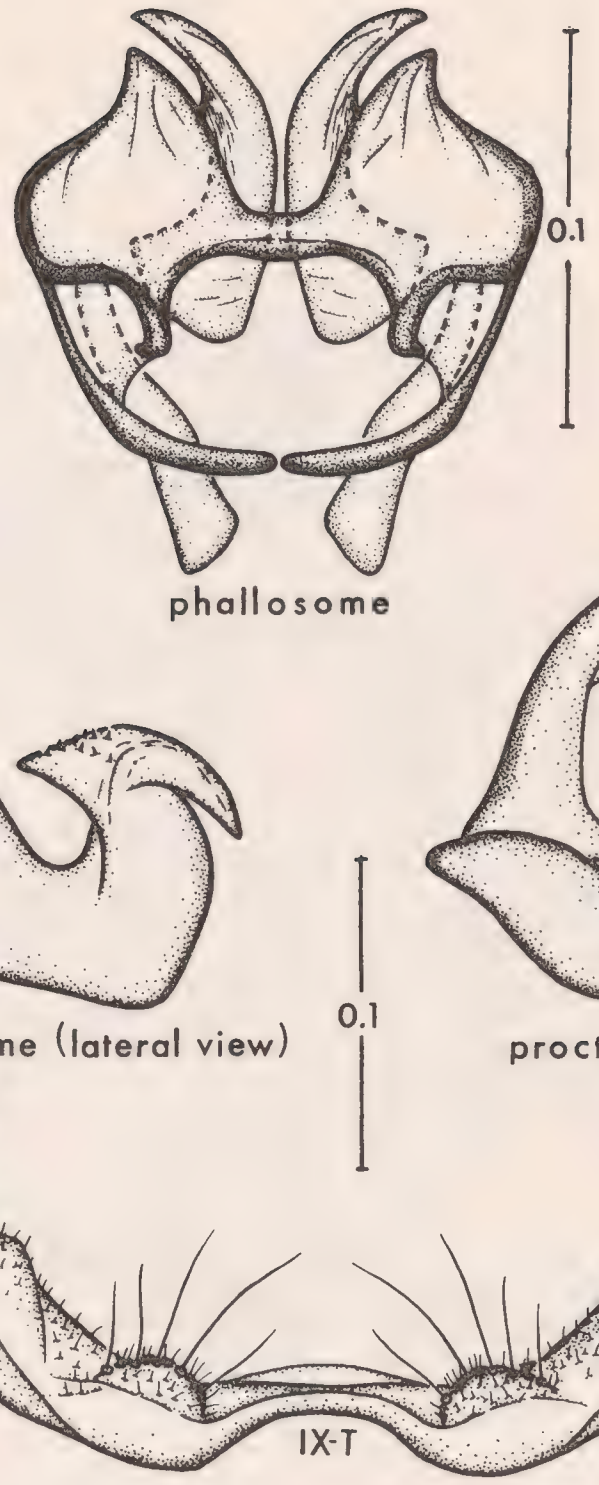


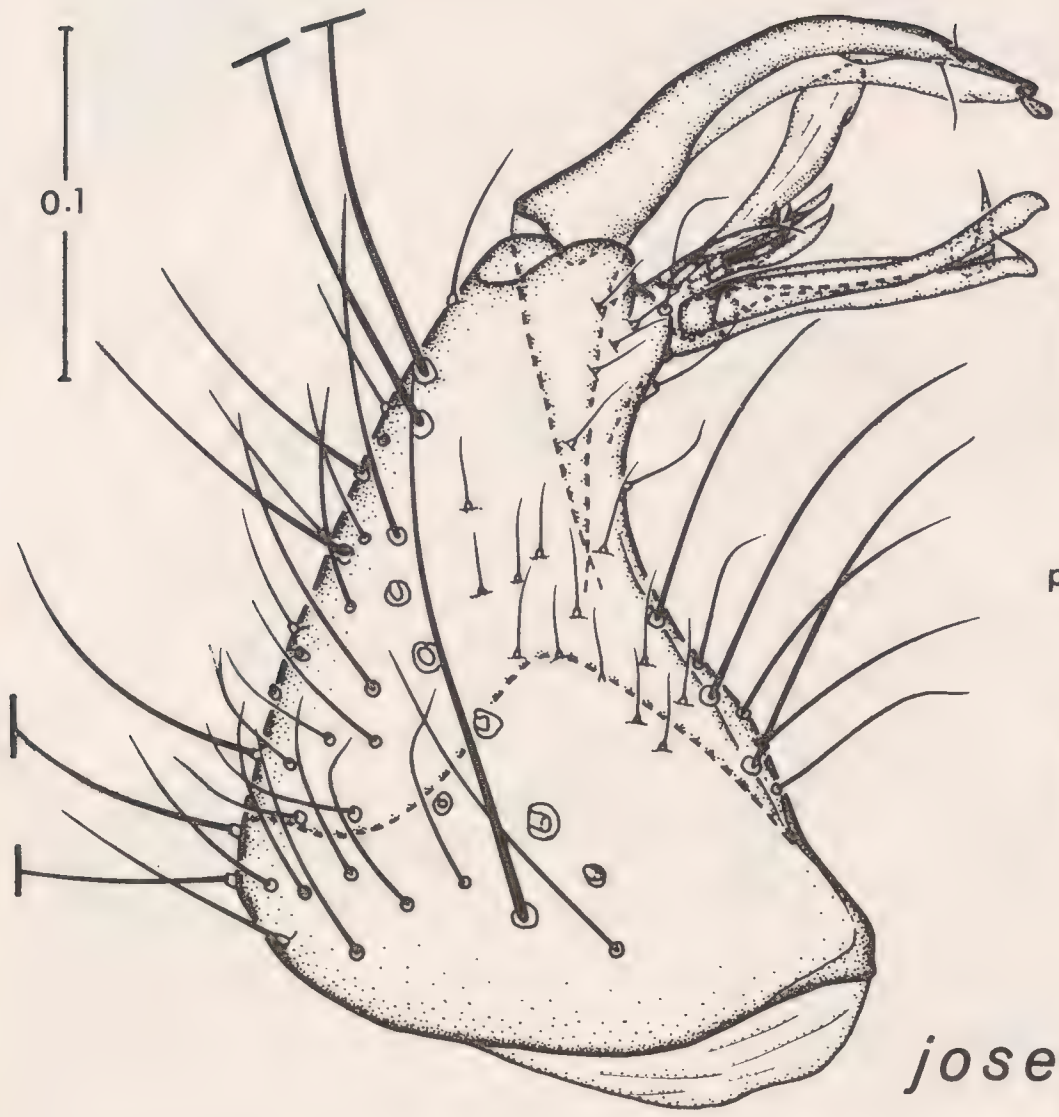
variatus

C. Chang

Fig. 21

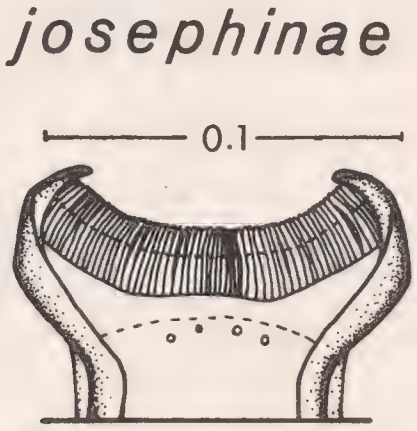


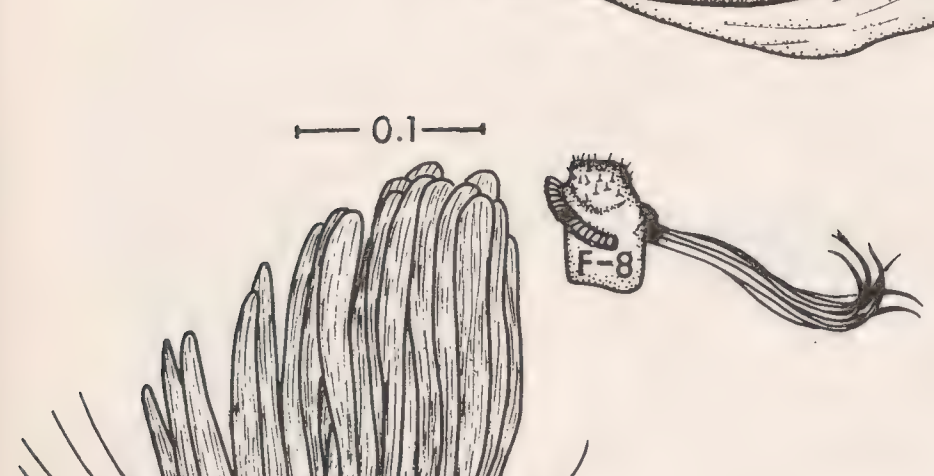


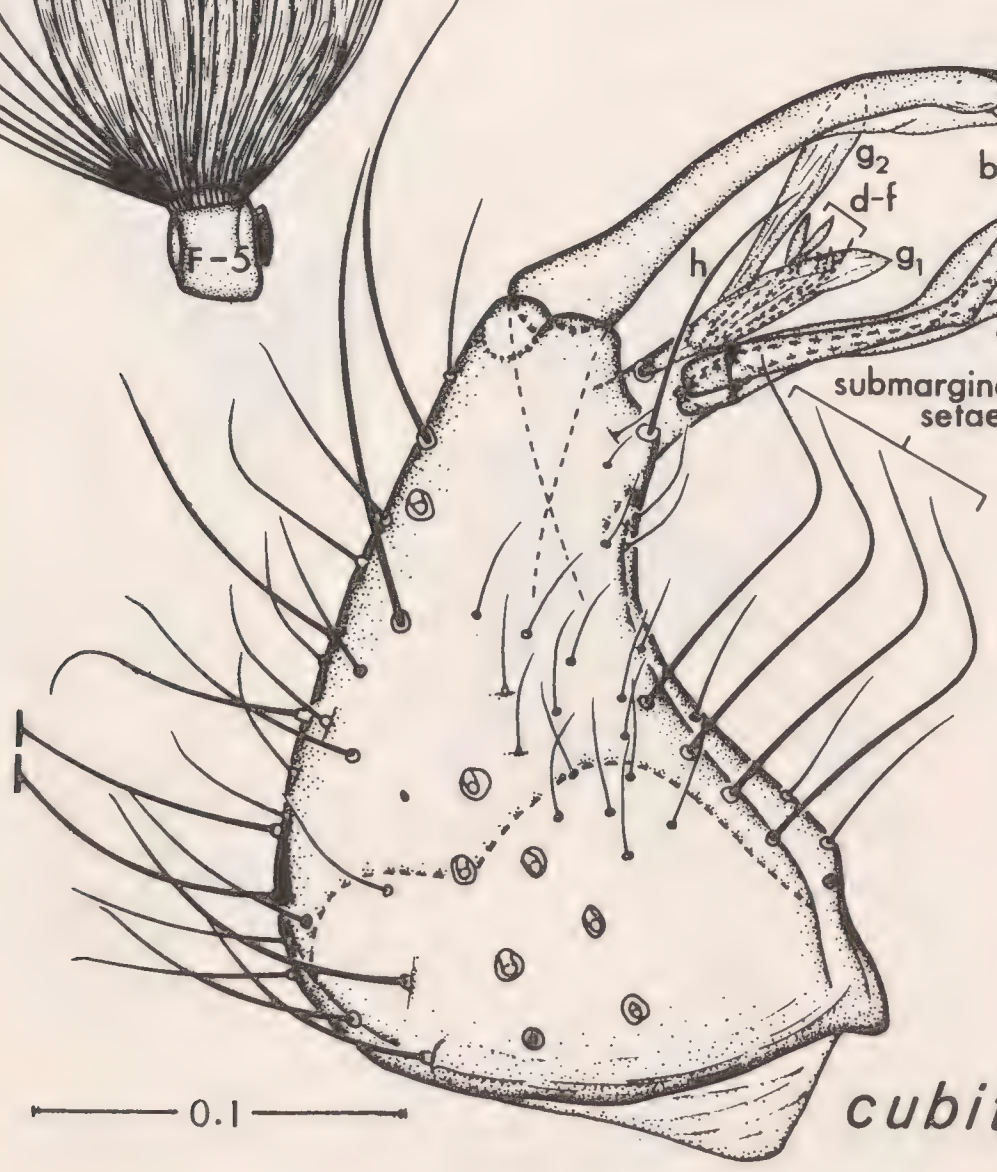


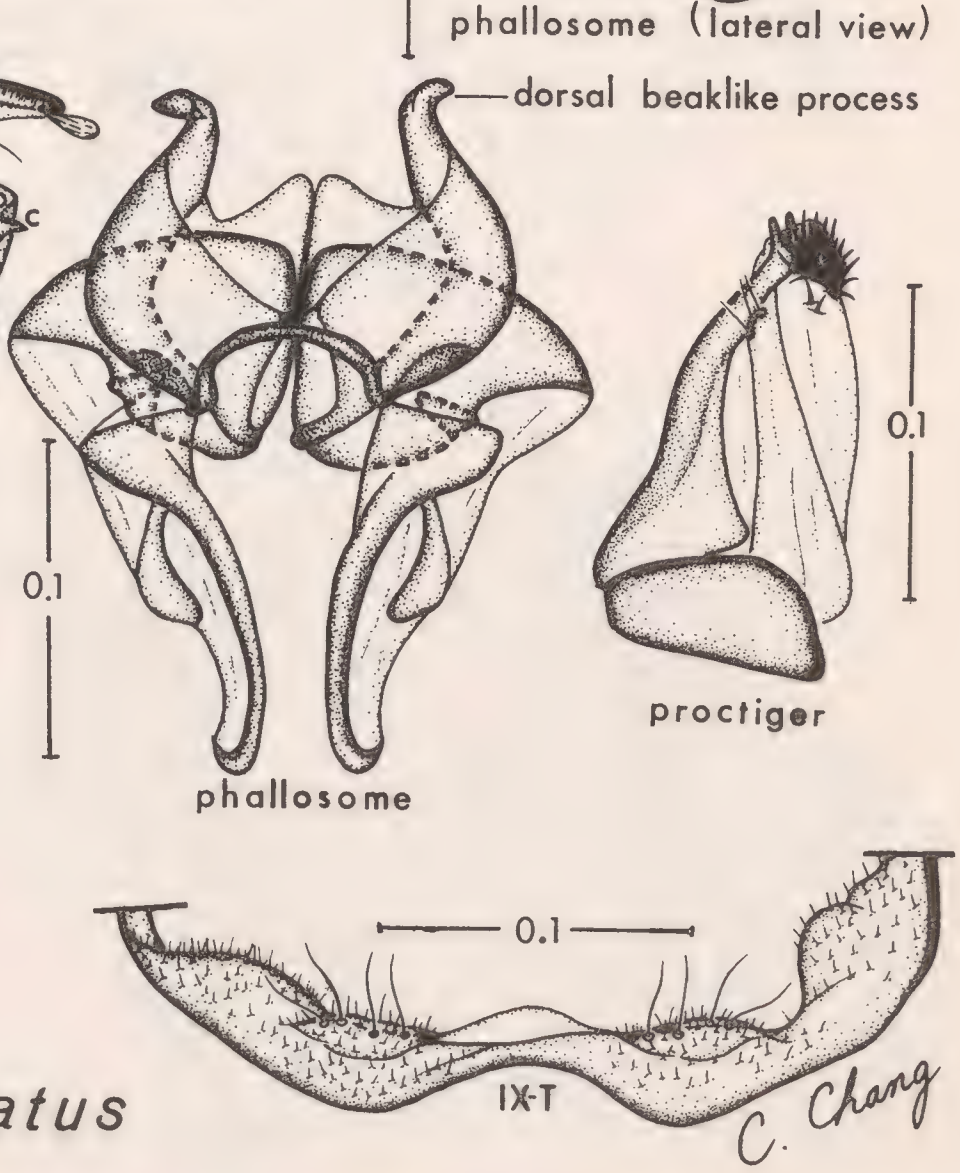
josephinae







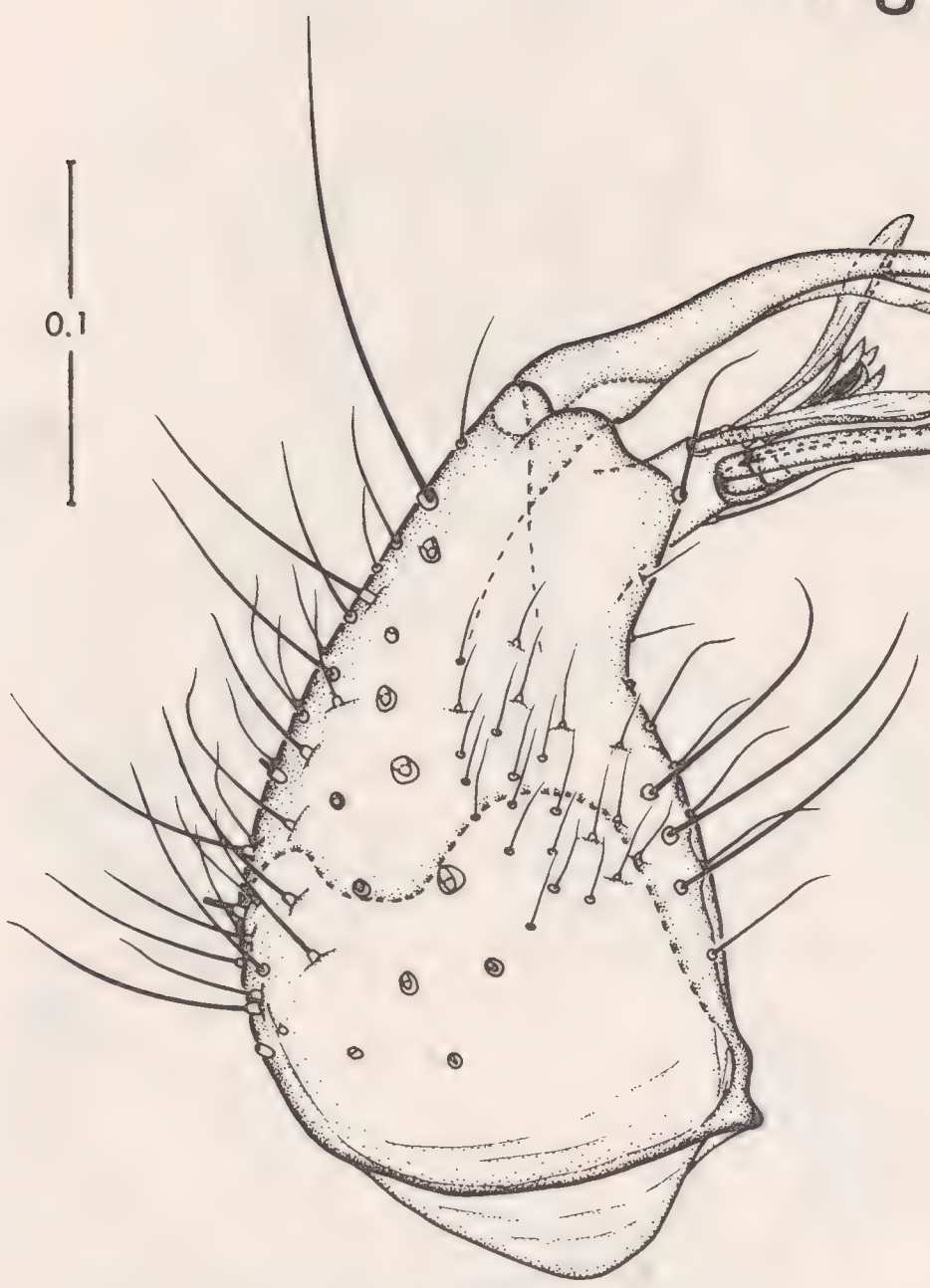




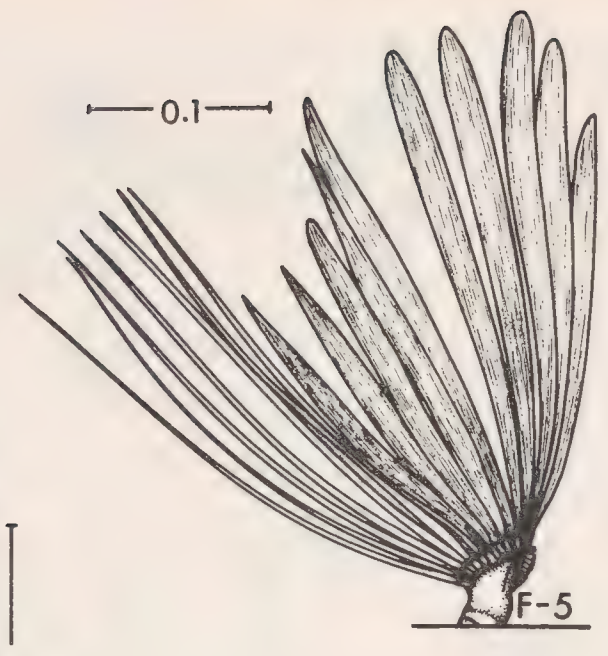
cubitatus

C. Chang

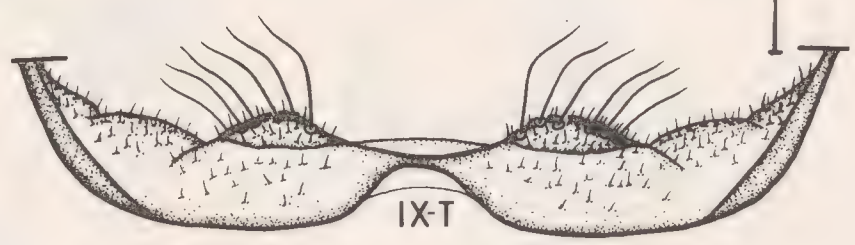
Fig. 22





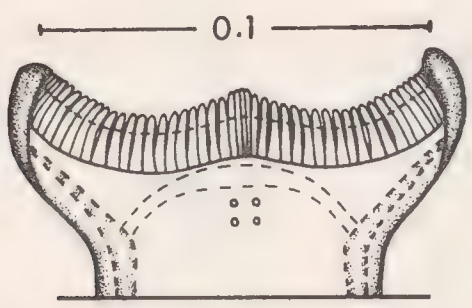


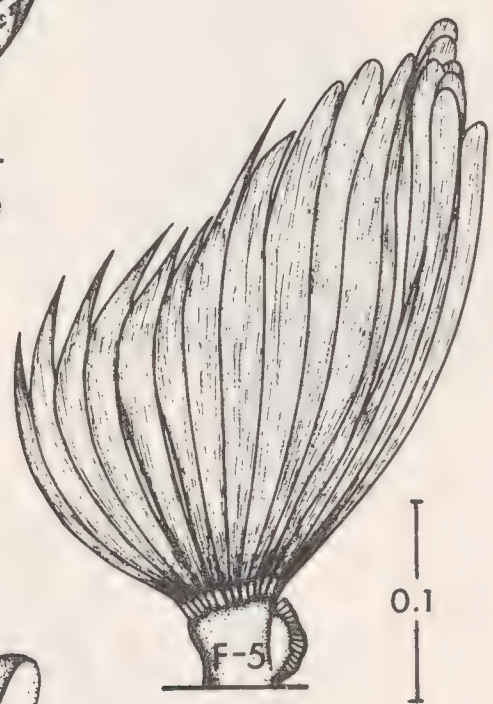


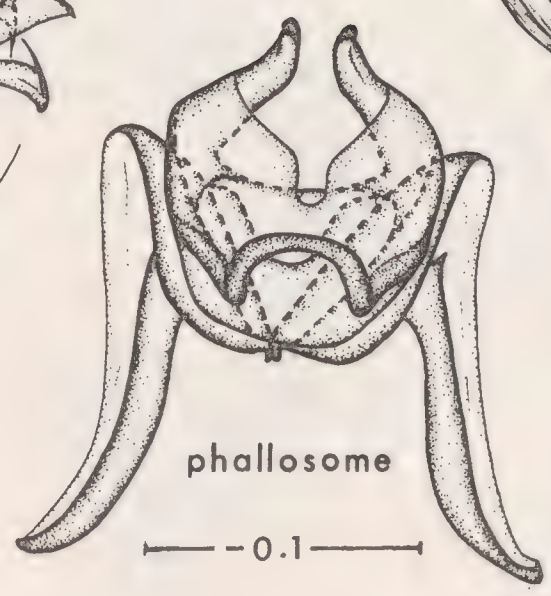


gracicornis





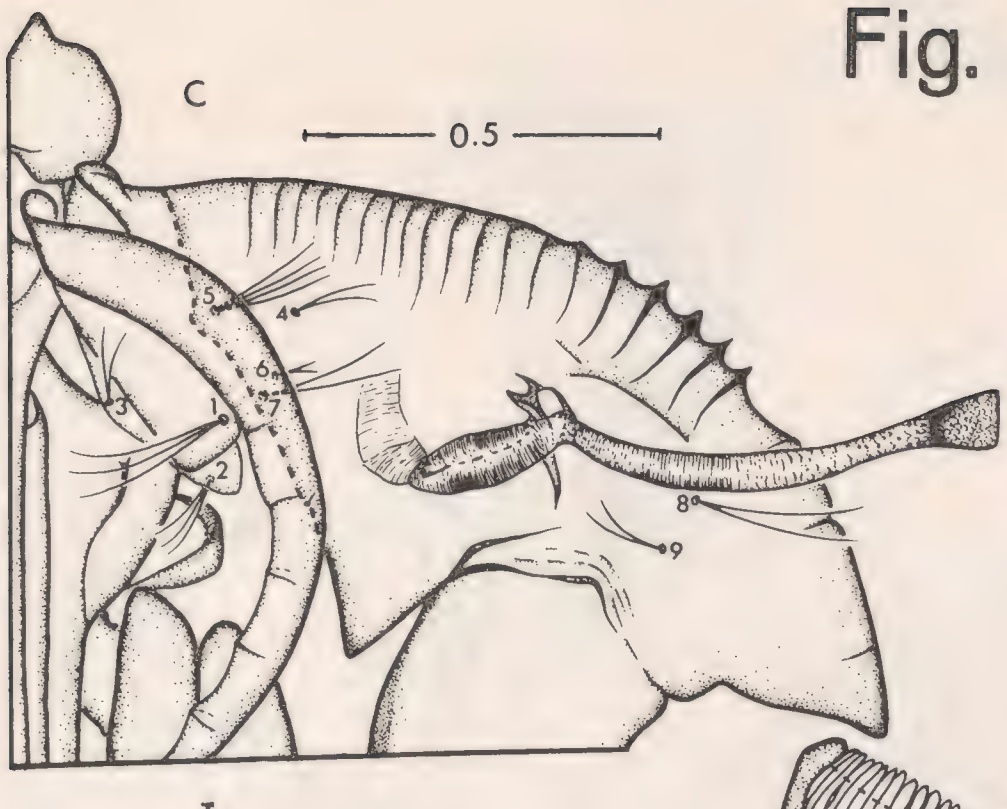


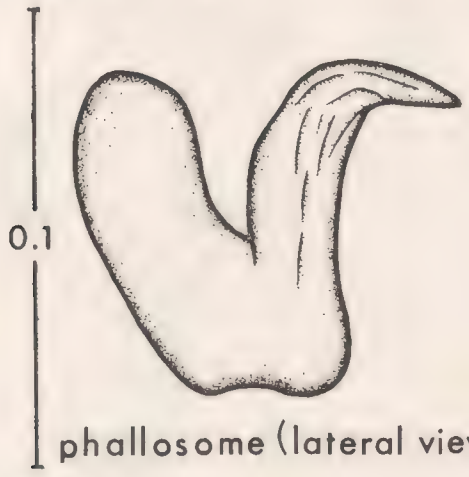


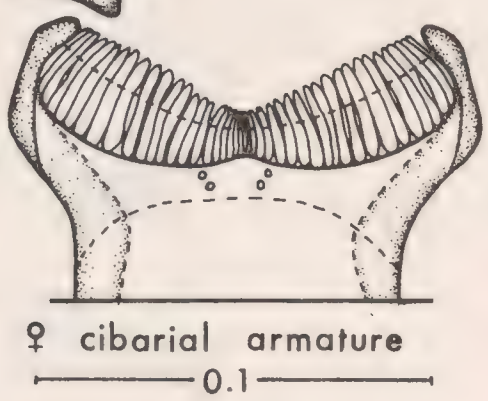
C. Chang

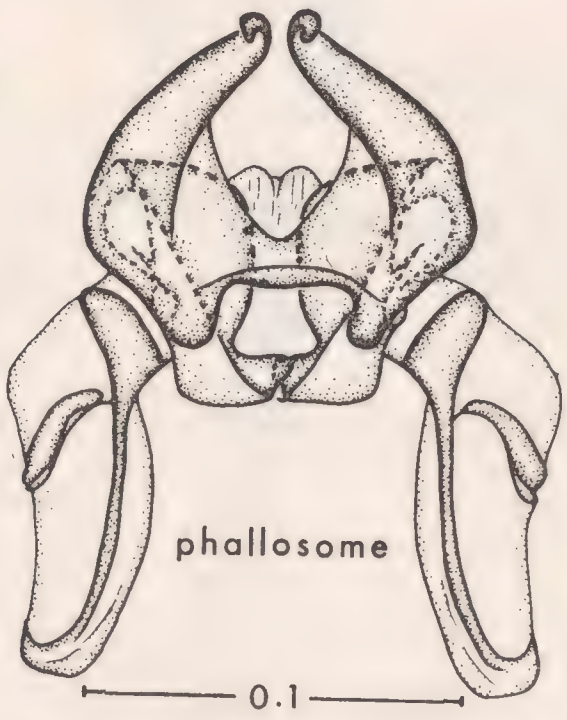
whartoni

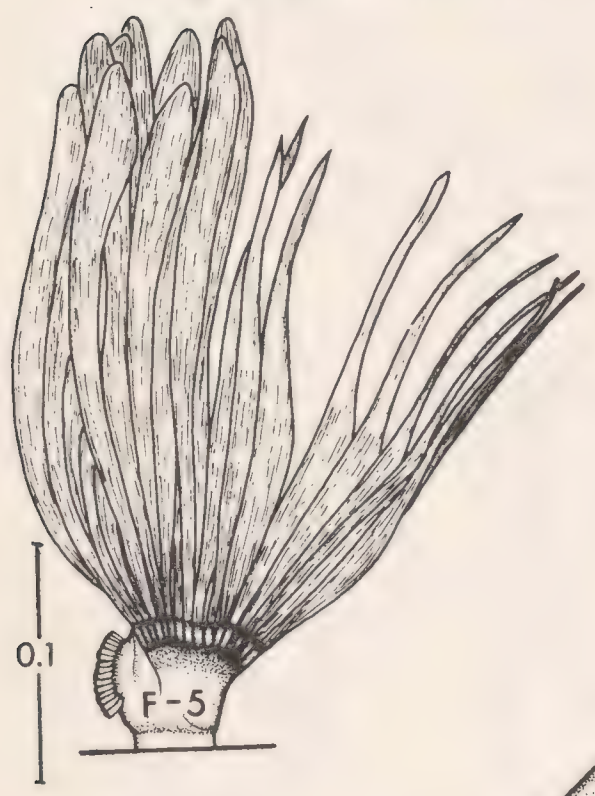
Fig. 23

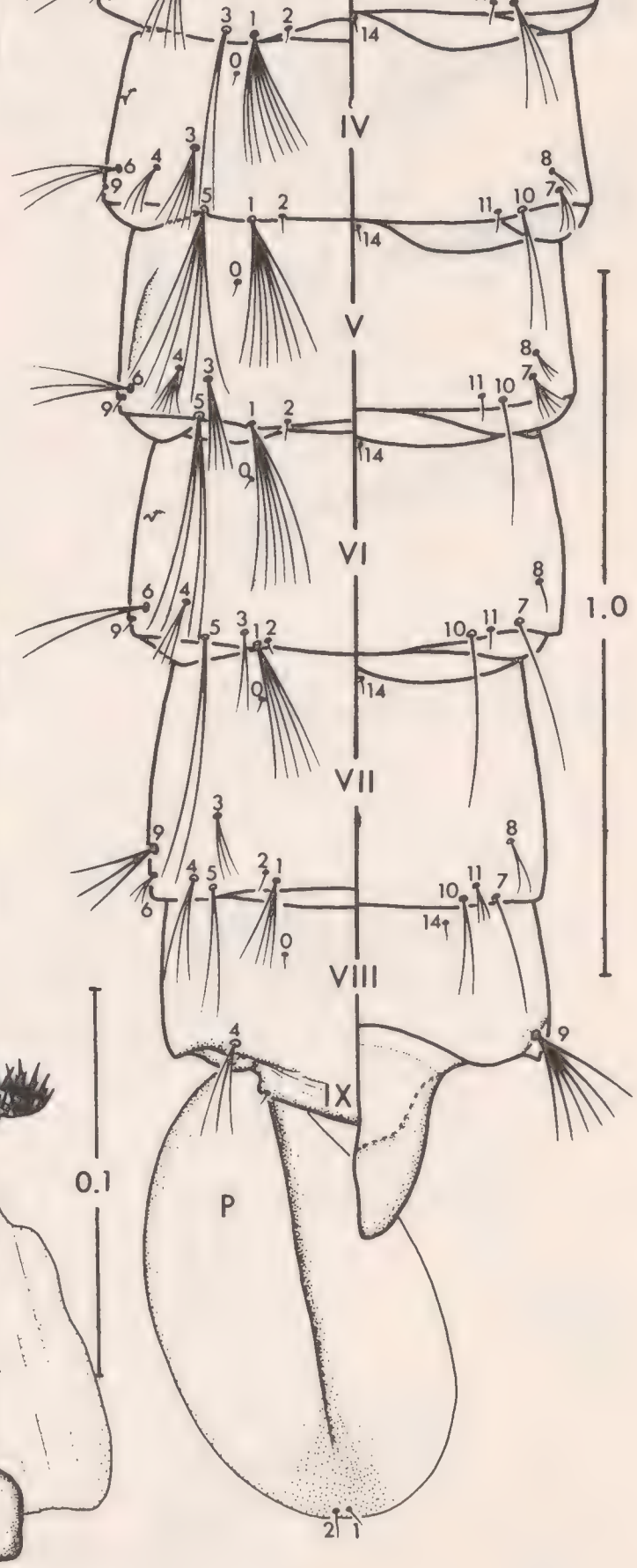


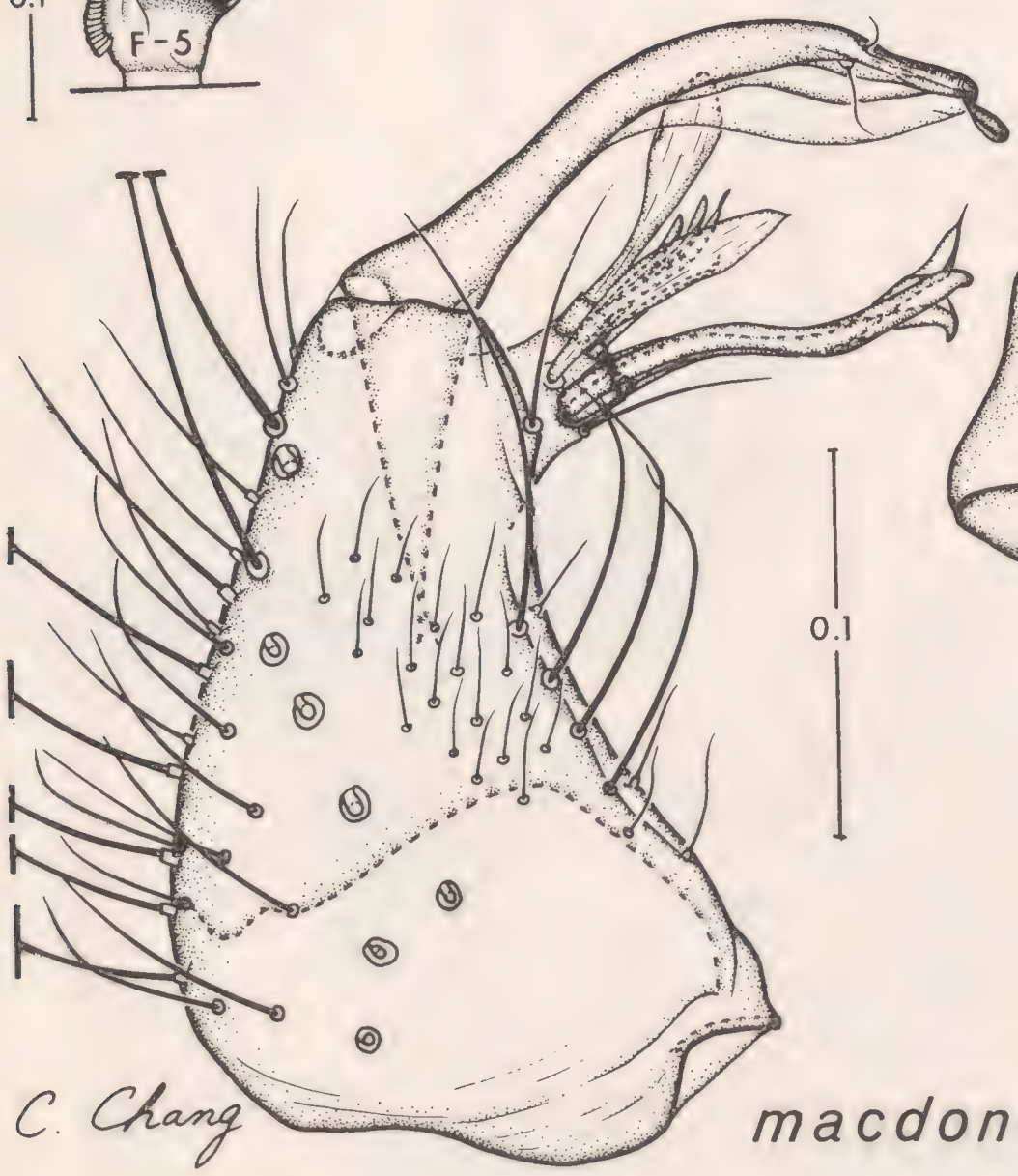




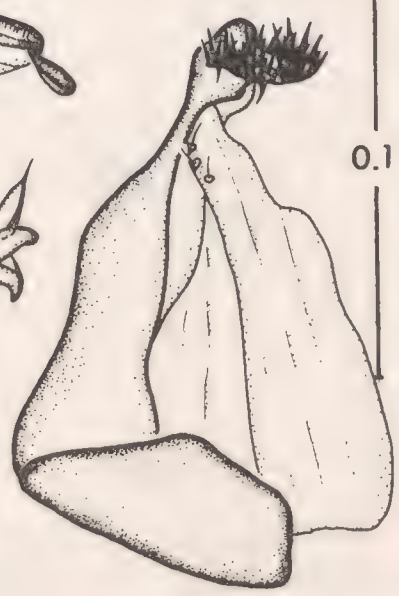








macdonaldi



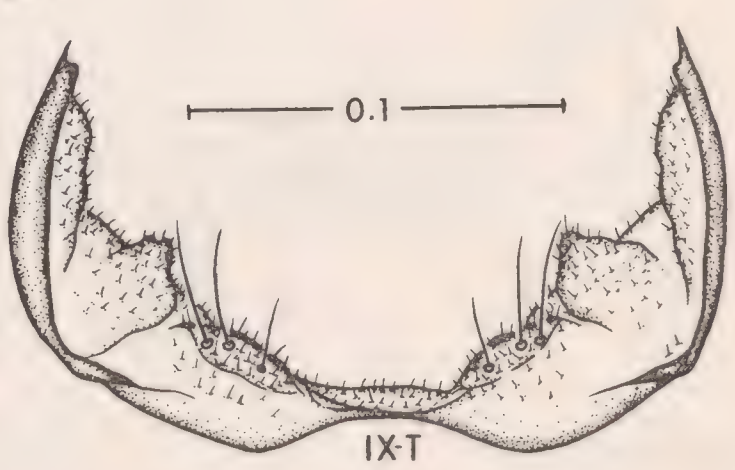
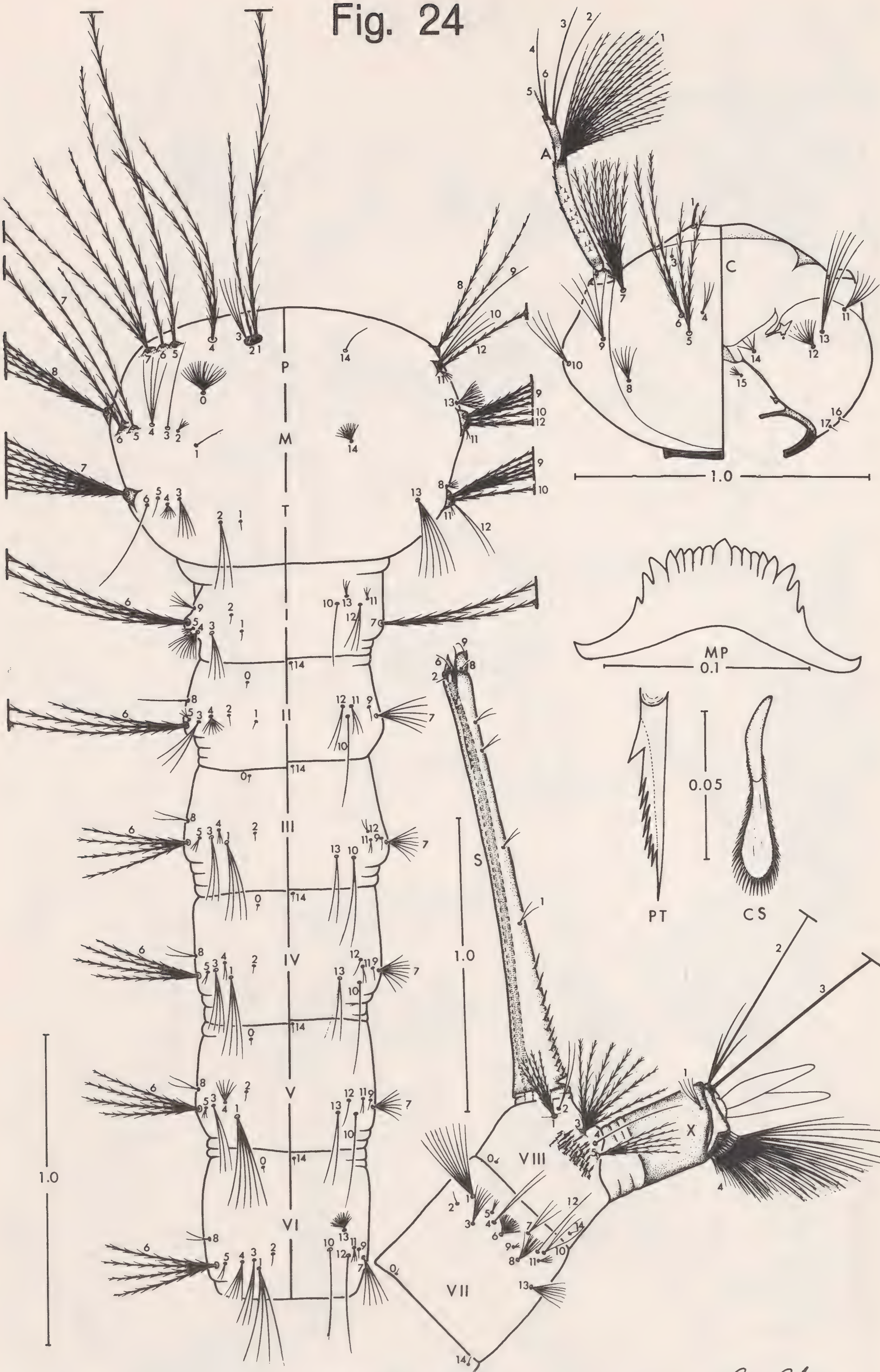


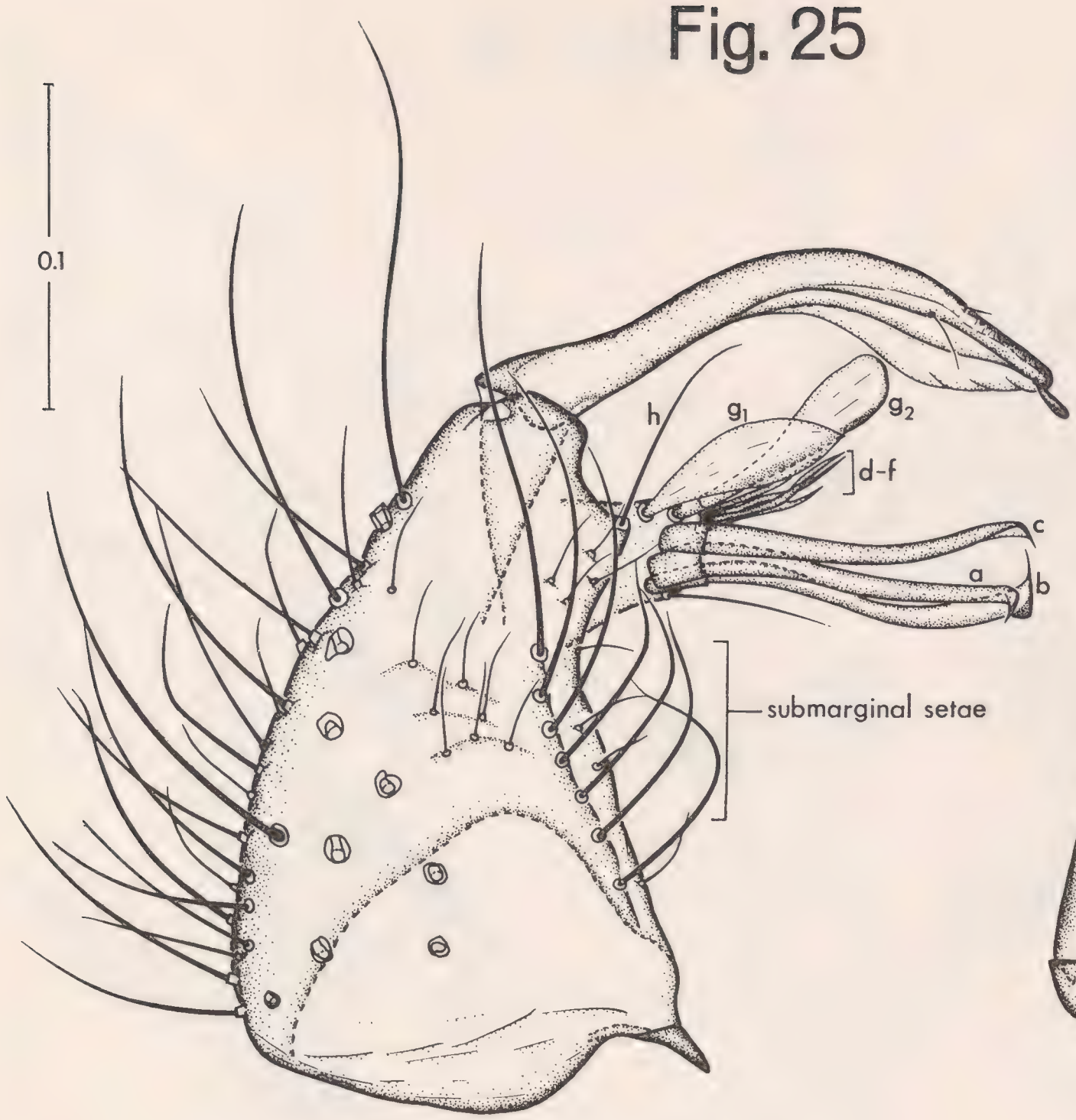
Fig. 24



macdonaldi

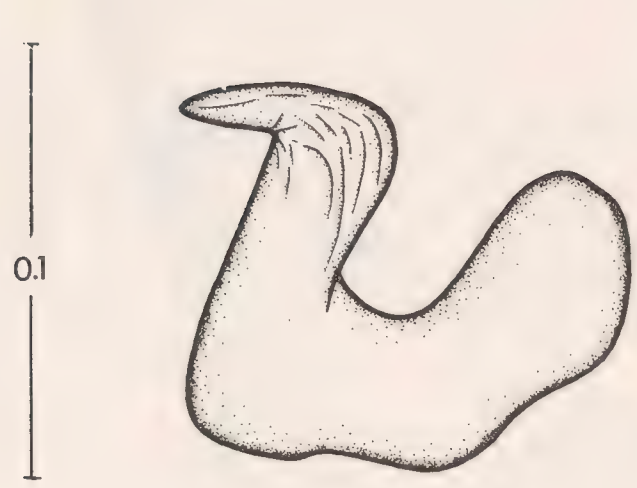
C. Chang

Fig. 25

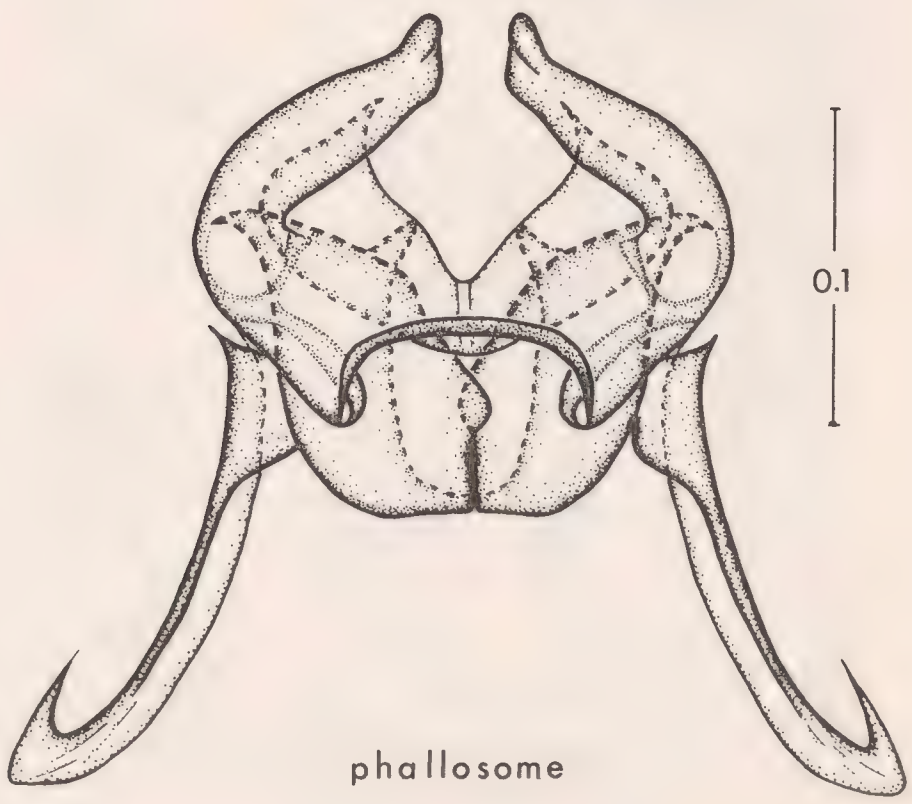




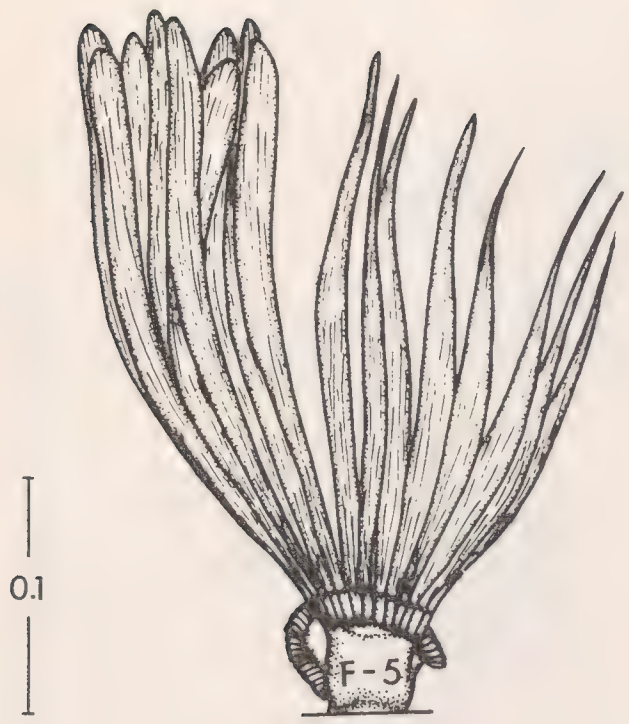
proctiger



phallosome (lateral view)



phallosome





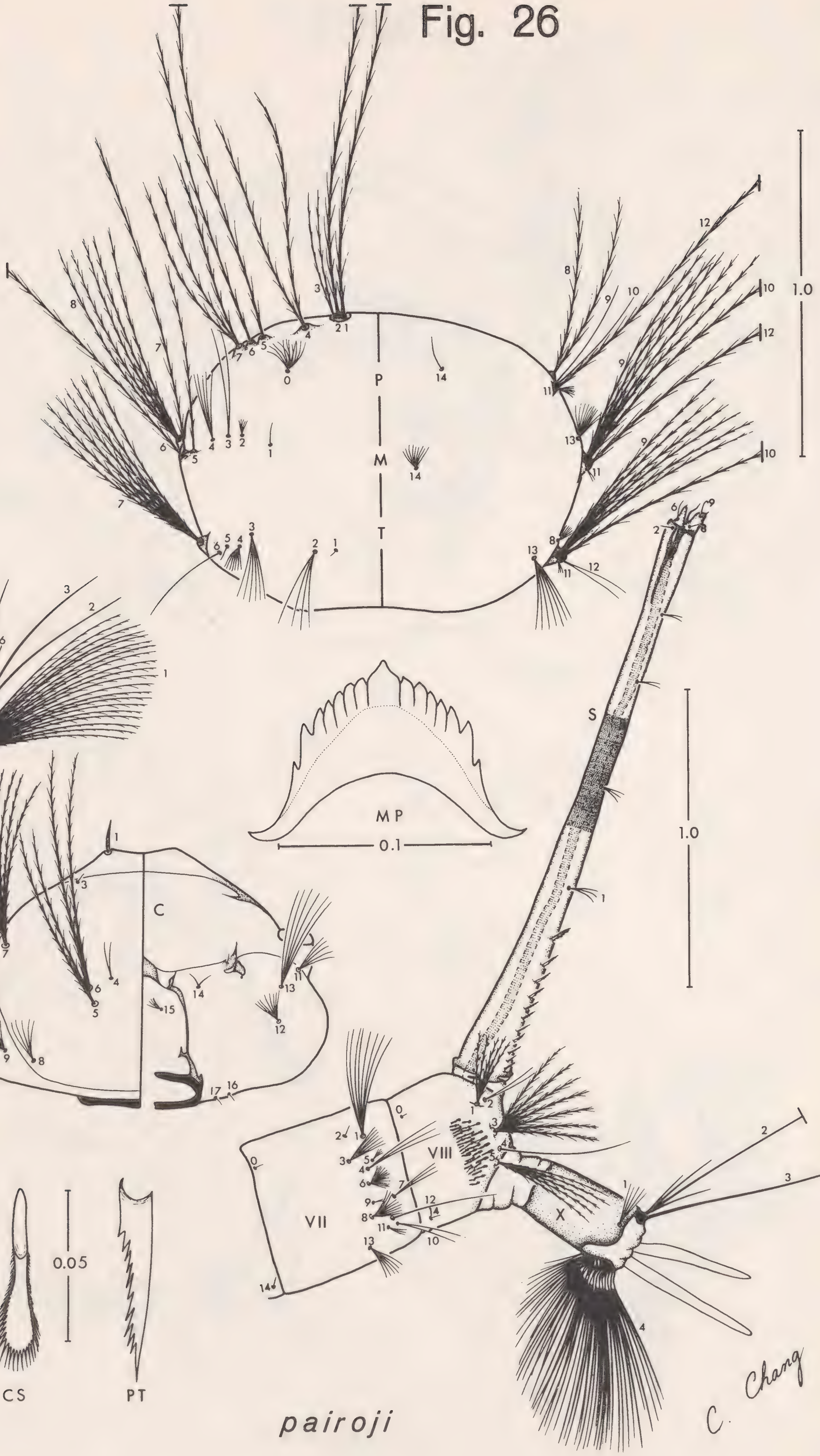
IX-T

0.1

pairoji

C. Chang

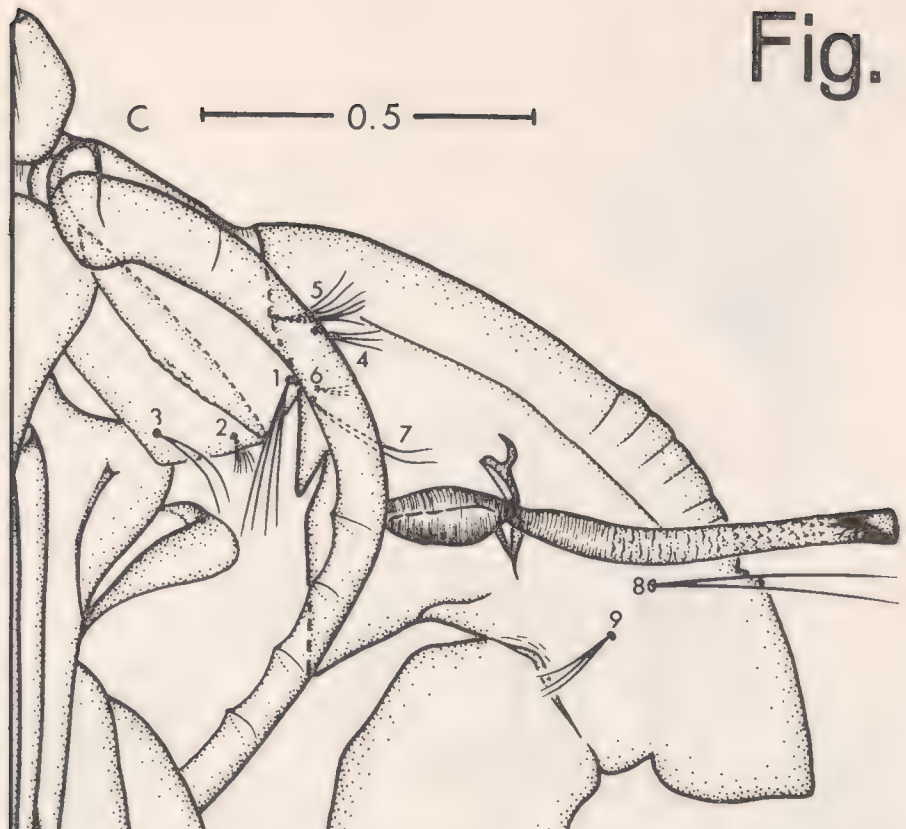
Fig. 26

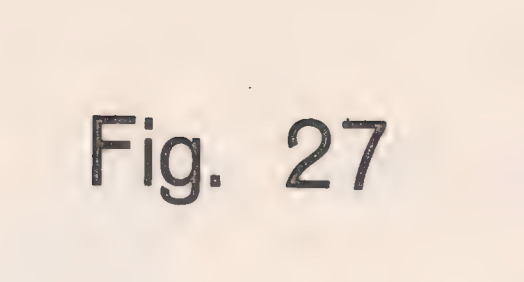


pairoji

C. Chang

Fig. 27





♀ cibarial armature

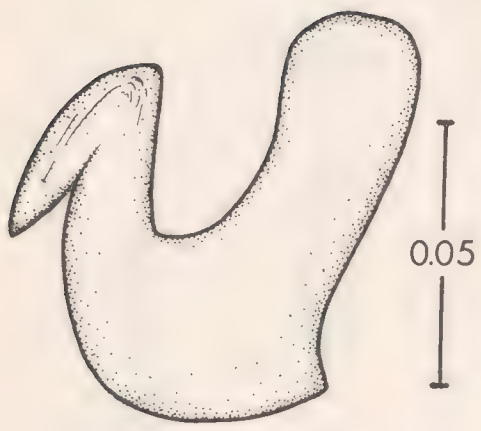


0.1

0.1

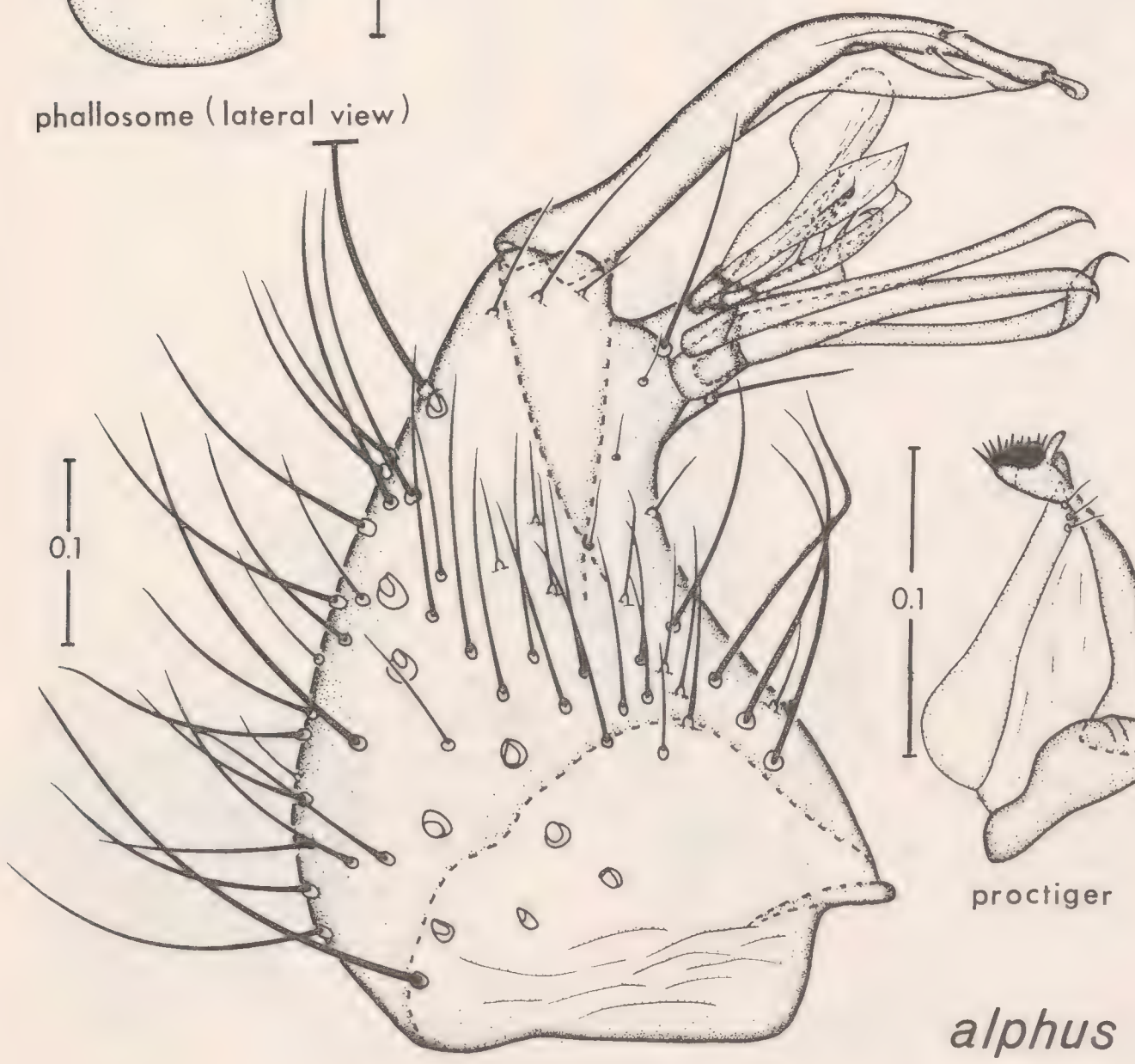


IX - T



0.05

phallosome (lateral view)



0.1



0.1

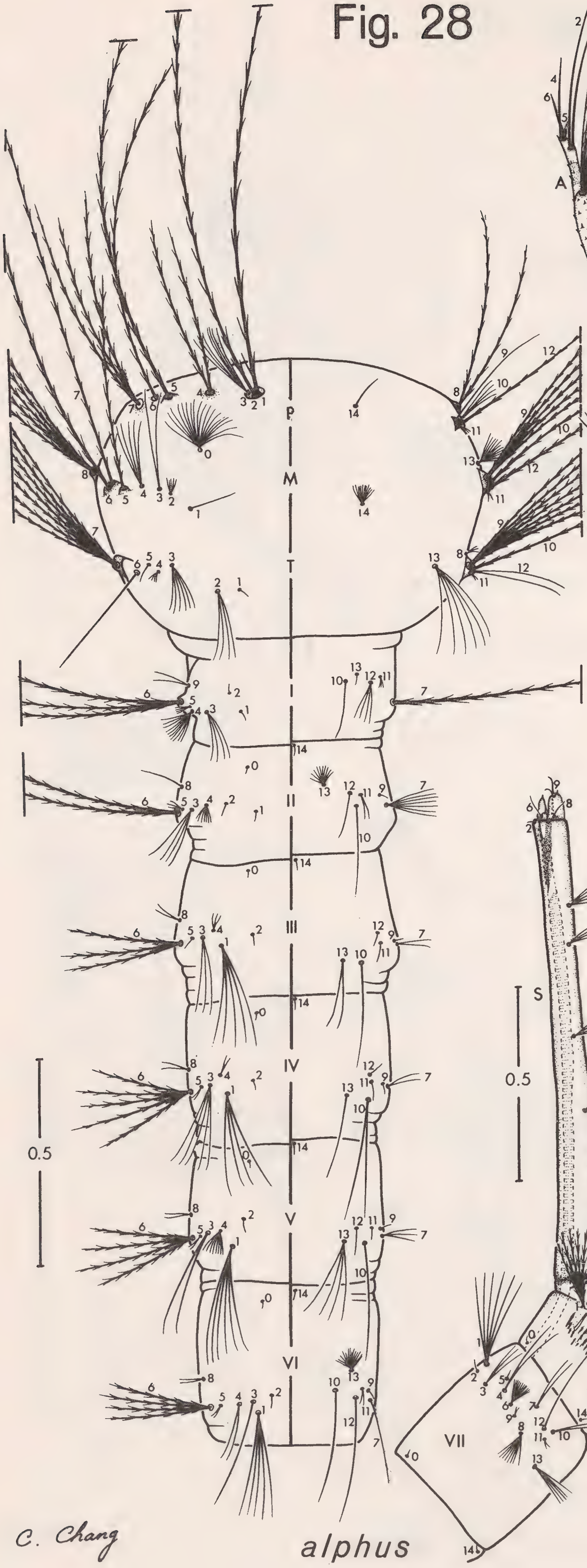
proctiger

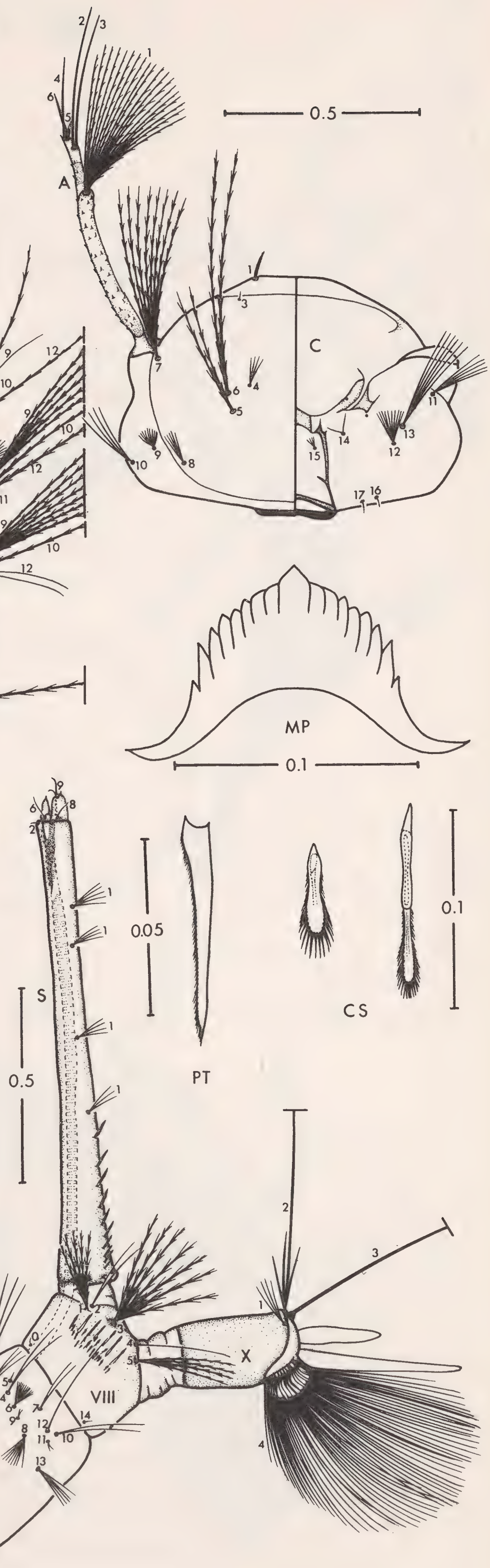
0.5

alphus

C. Chang

Fig. 28

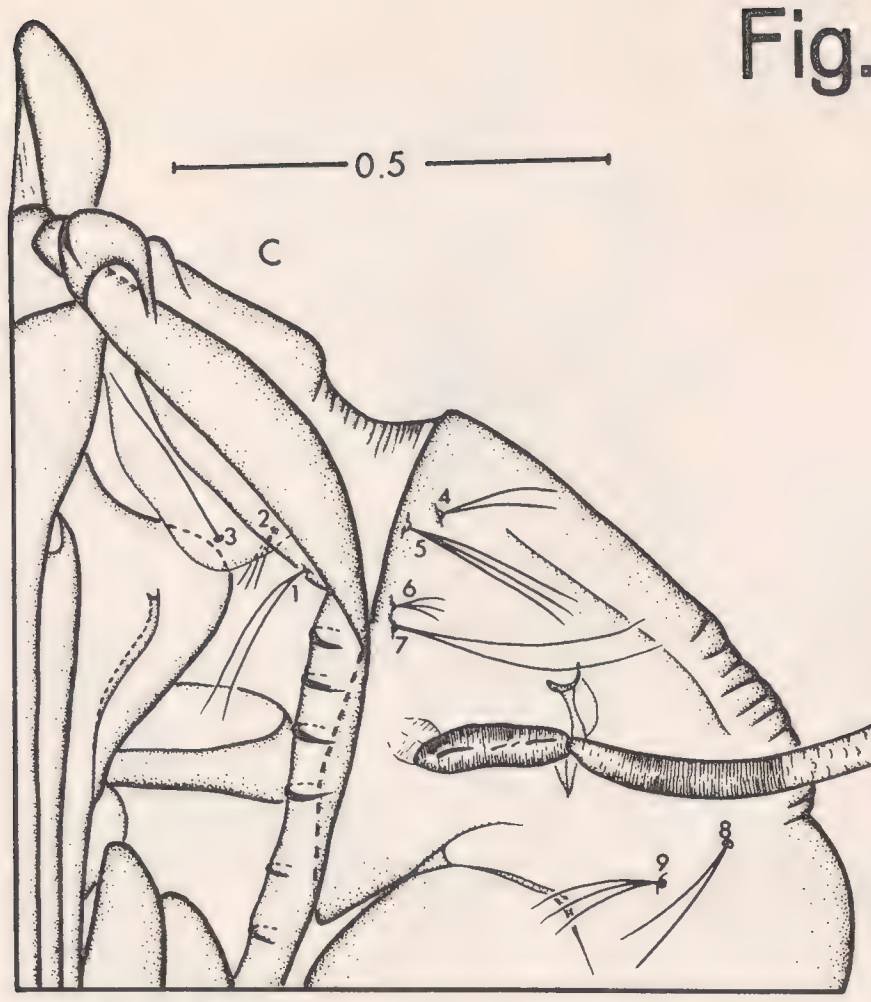


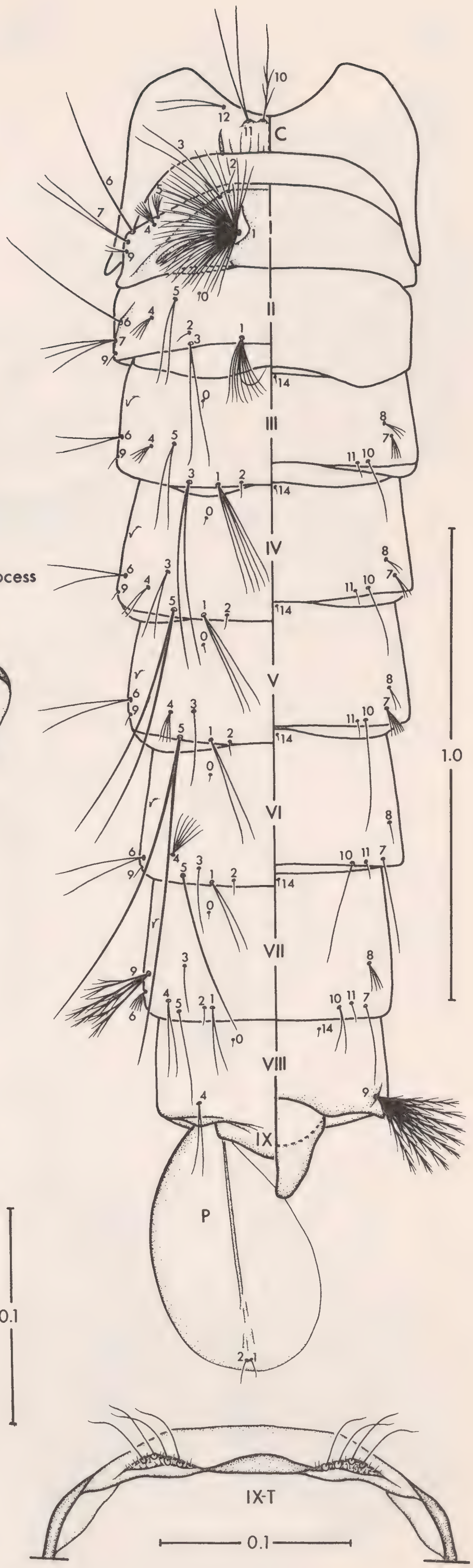


C. Chang

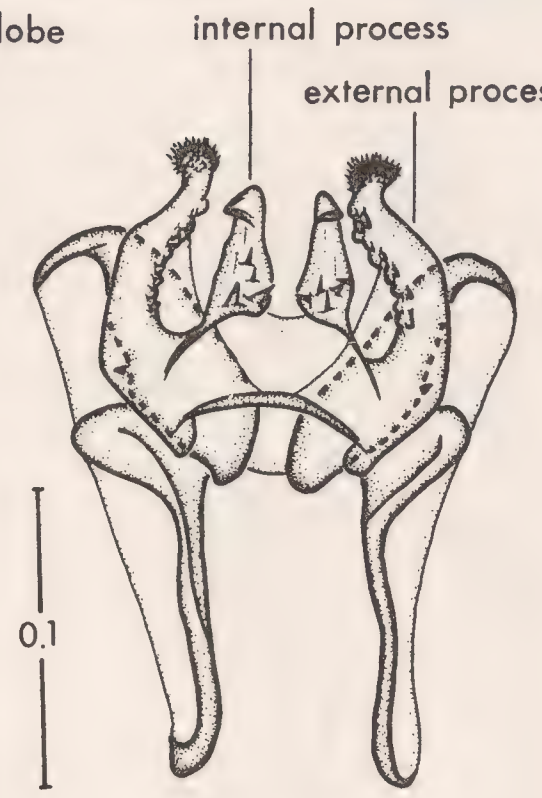
alphus

Fig. 29

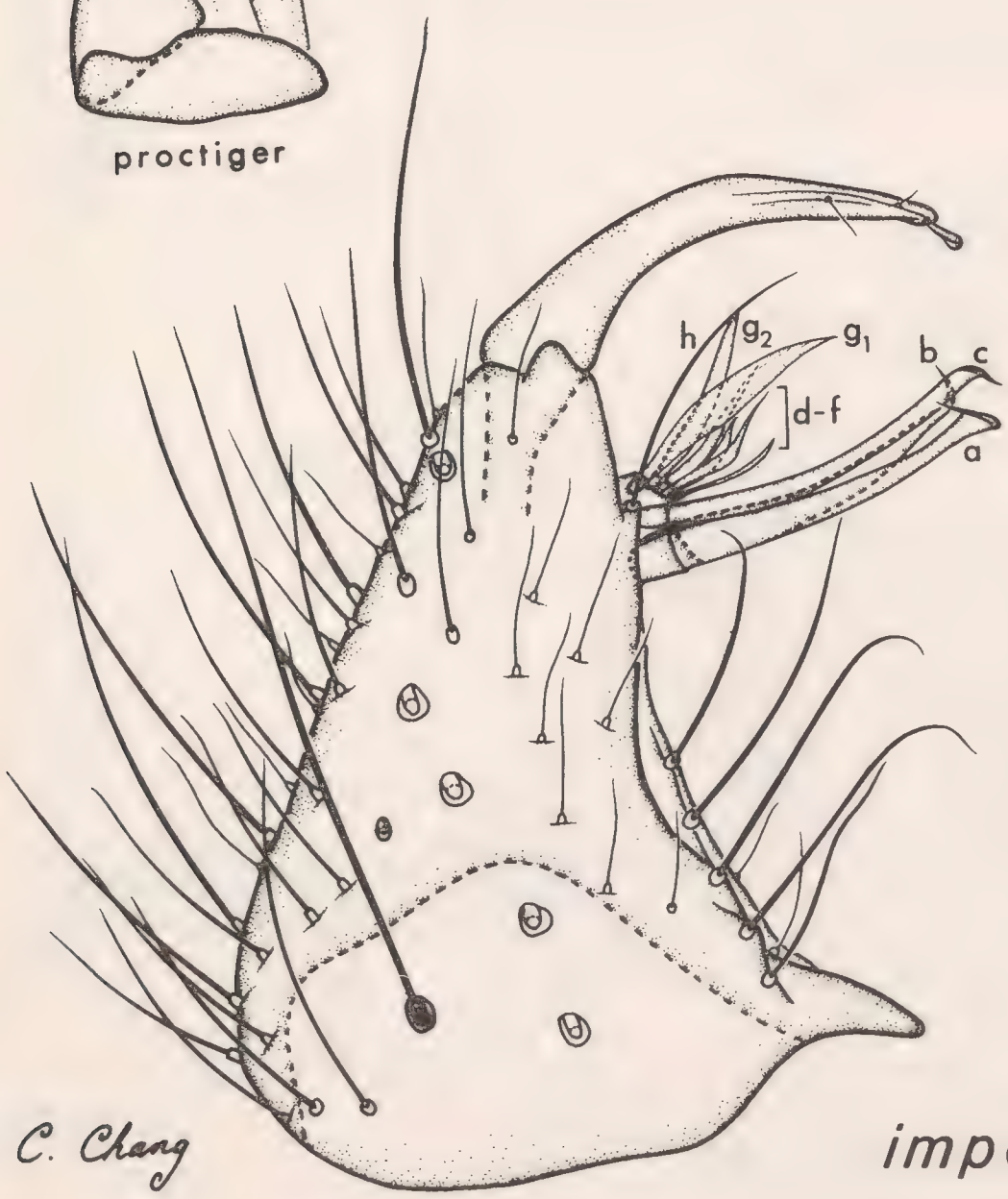












C. Chang

impostor

Fig. 30

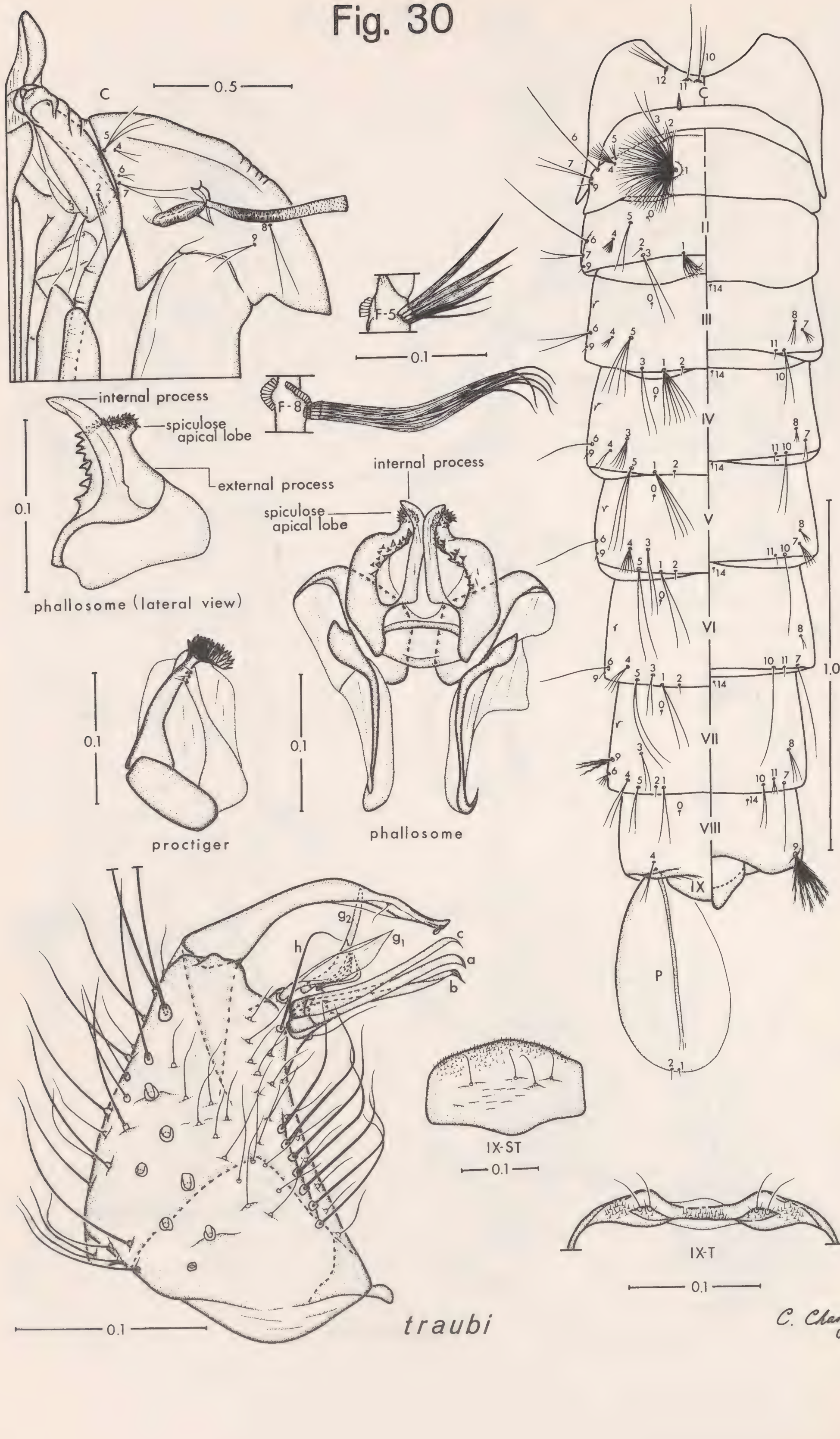
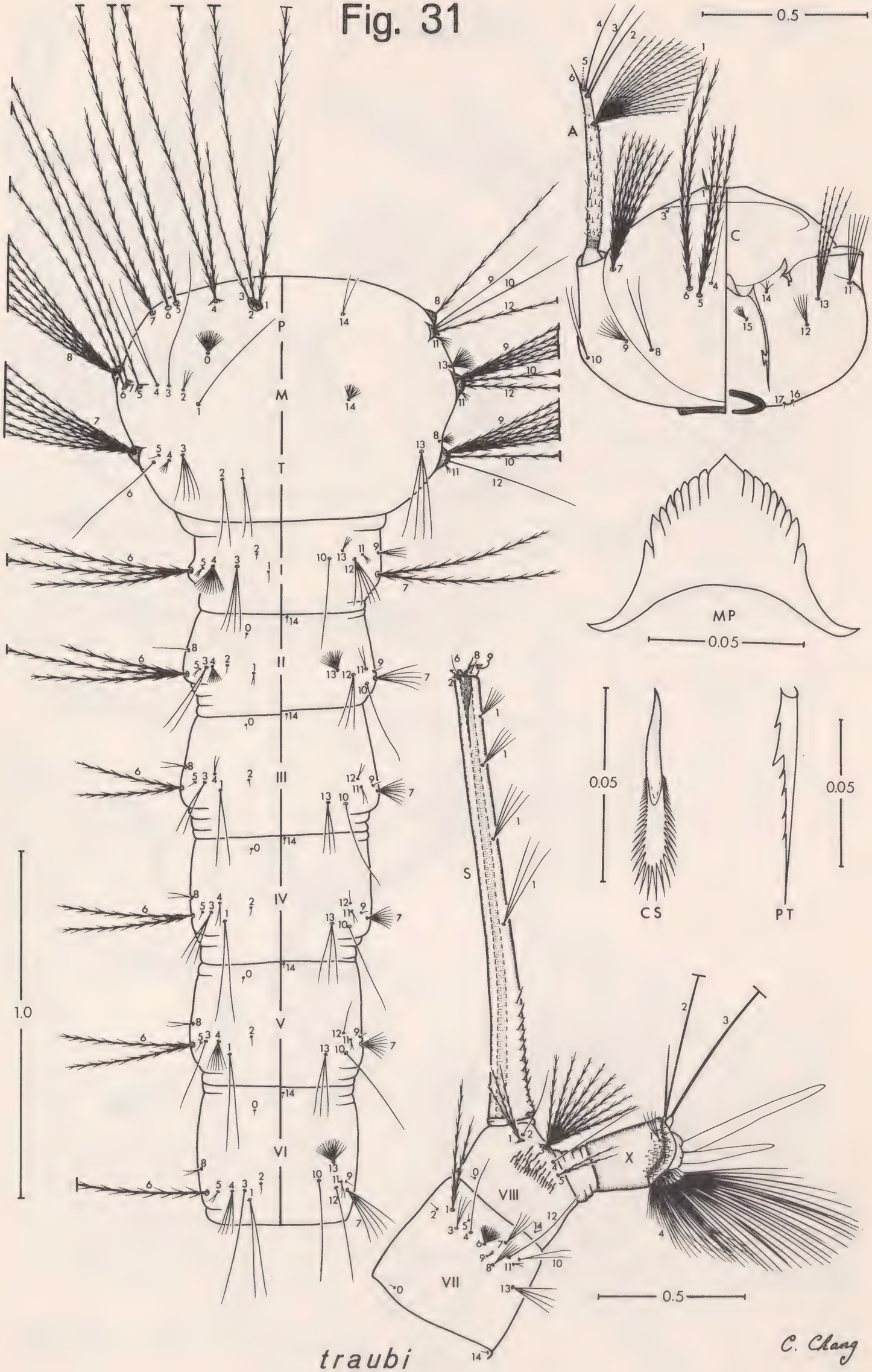

C
0.5
internal process
spiculose apical lobe
external process
0.1
phallosome (lateral view)
F-5
0.1
F-8
internal process
spiculose apical lobe
0.1
0.1
proctiger
phallosome
C
III
IV
V
VI
VII
VIII
IX
P
1.0
g_2
g_1
h
c
a
b
IX-ST
0.1
IX-T
0.1
traubi
C. Chang

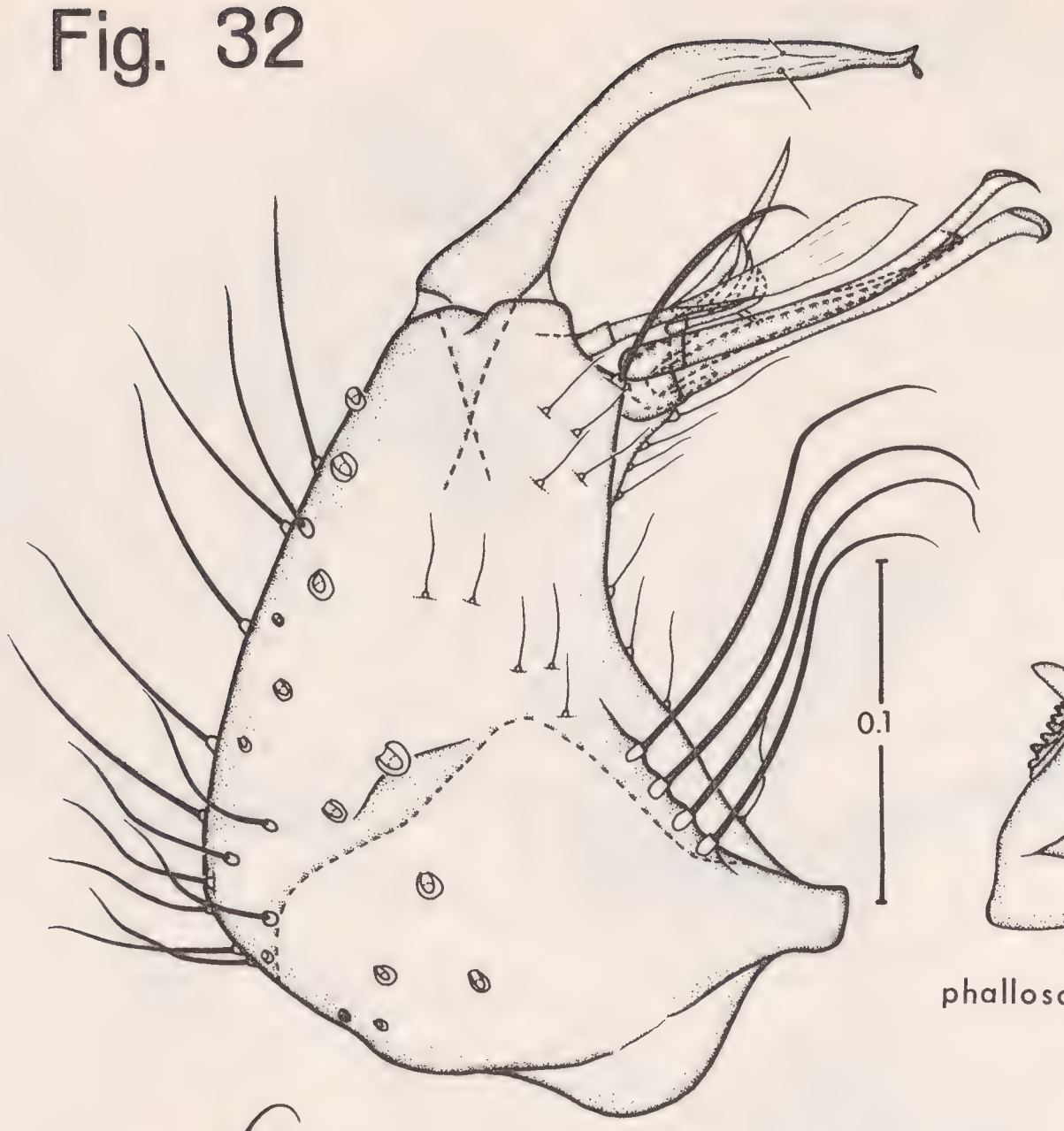
Fig. 31

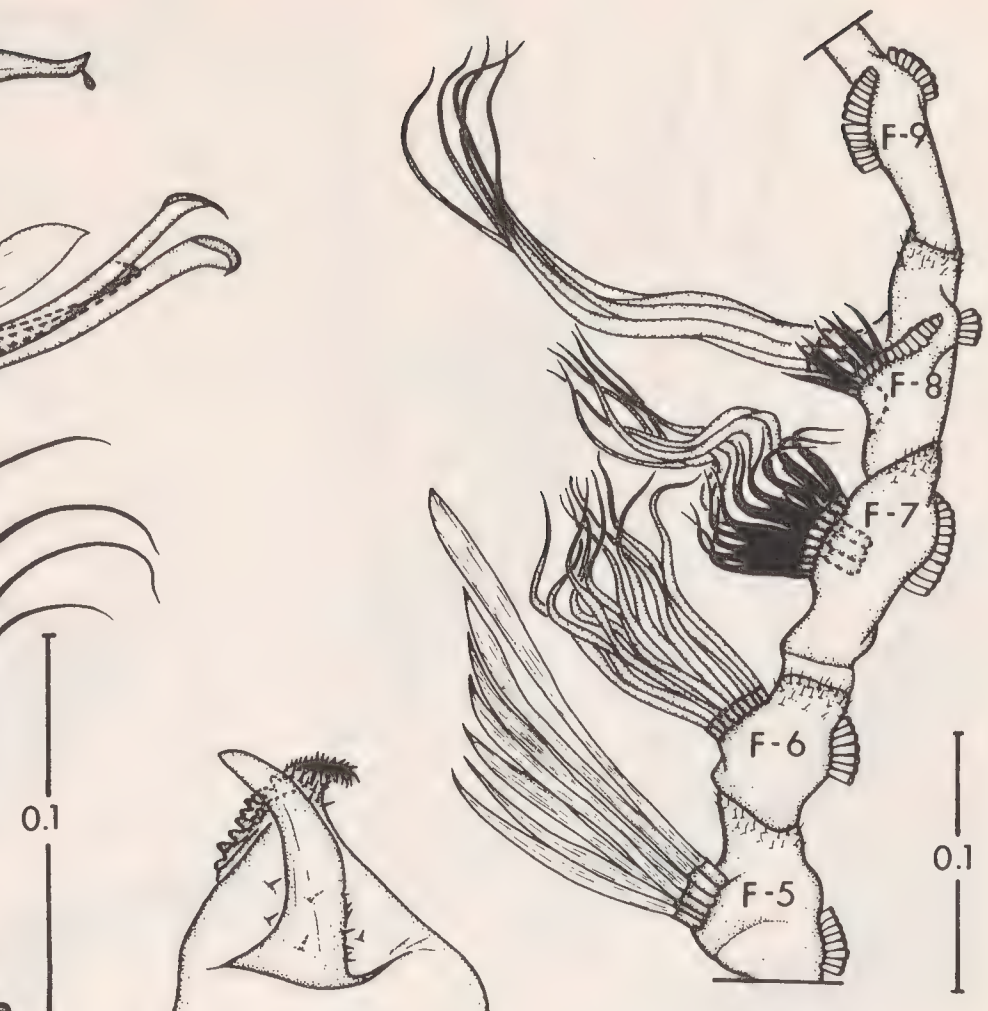


traubi

C. Chang

Fig. 32



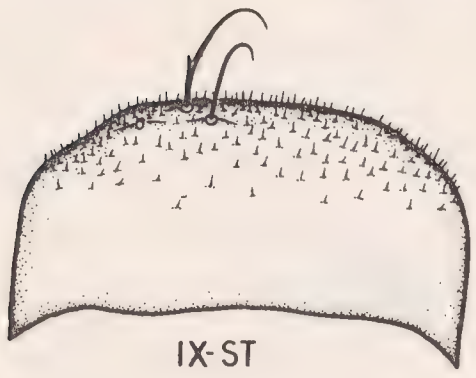


♂ antenna

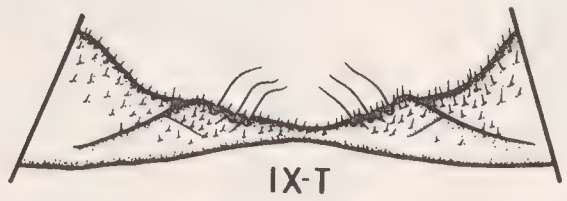
phallosome (lateral view)



proctiger



IX-ST



IX-T

uniformis



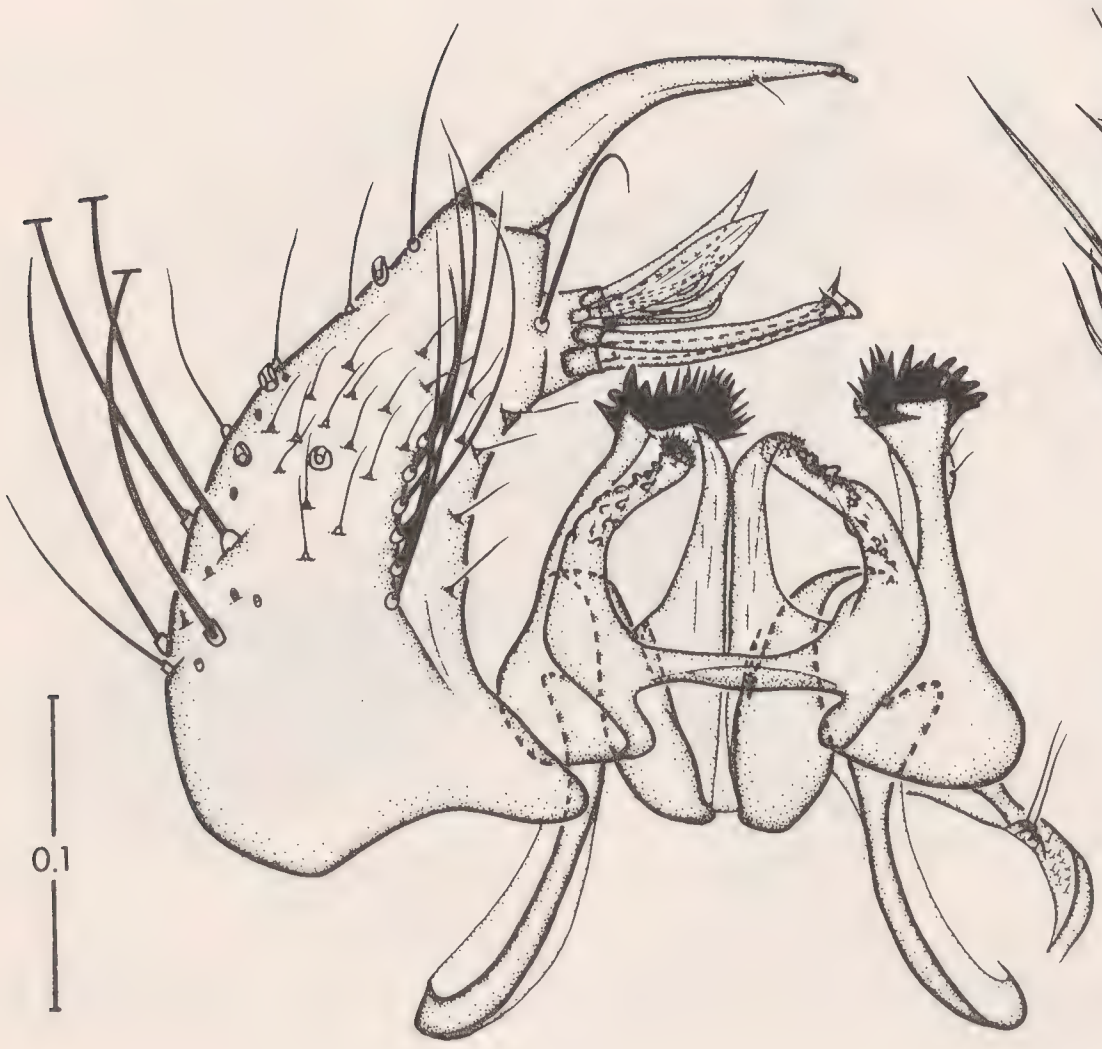
♂ antenna



phallosome (lateral view)



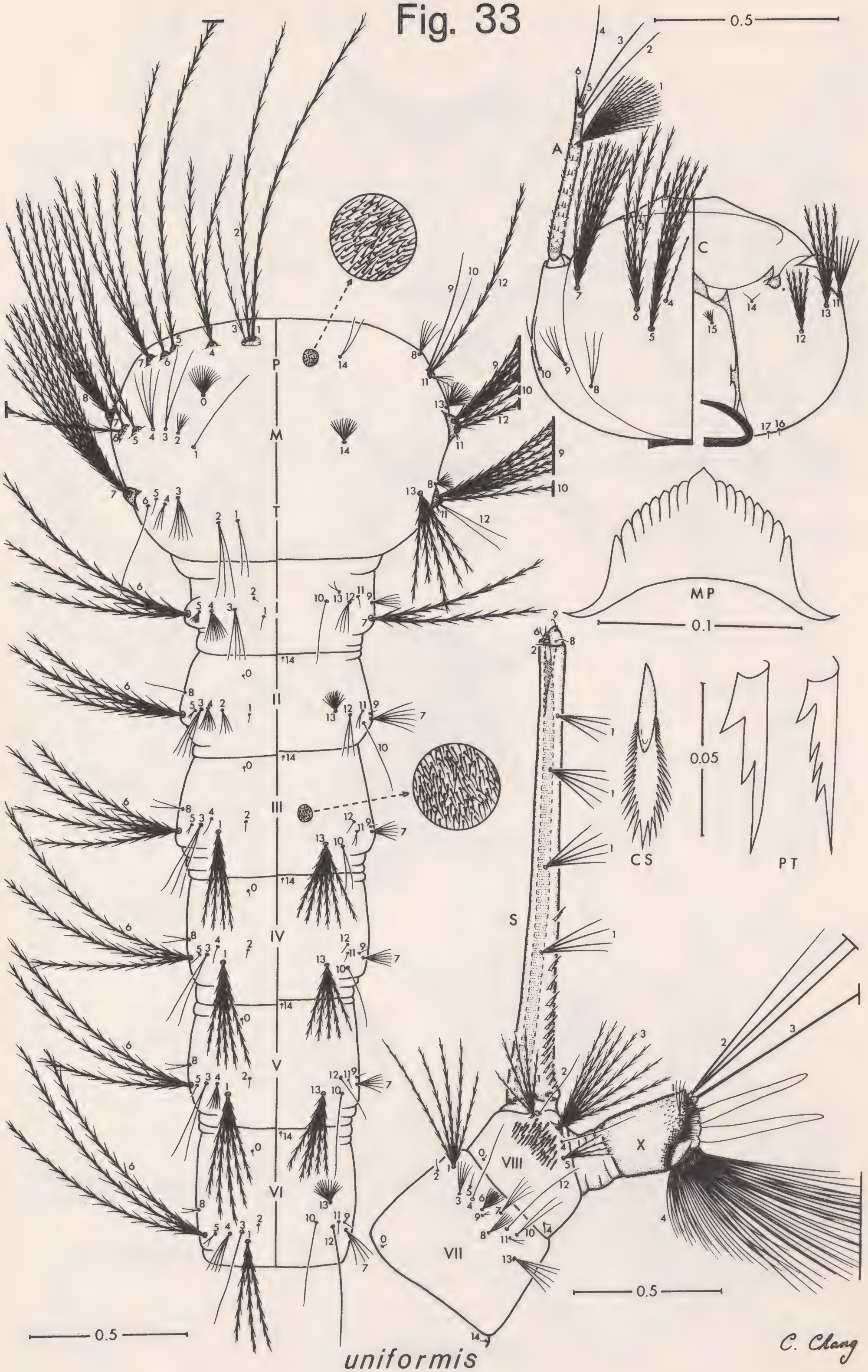
proctiger



lavatae

C. Chang

Fig. 33



uniformis

C. Chang

Fig. 34

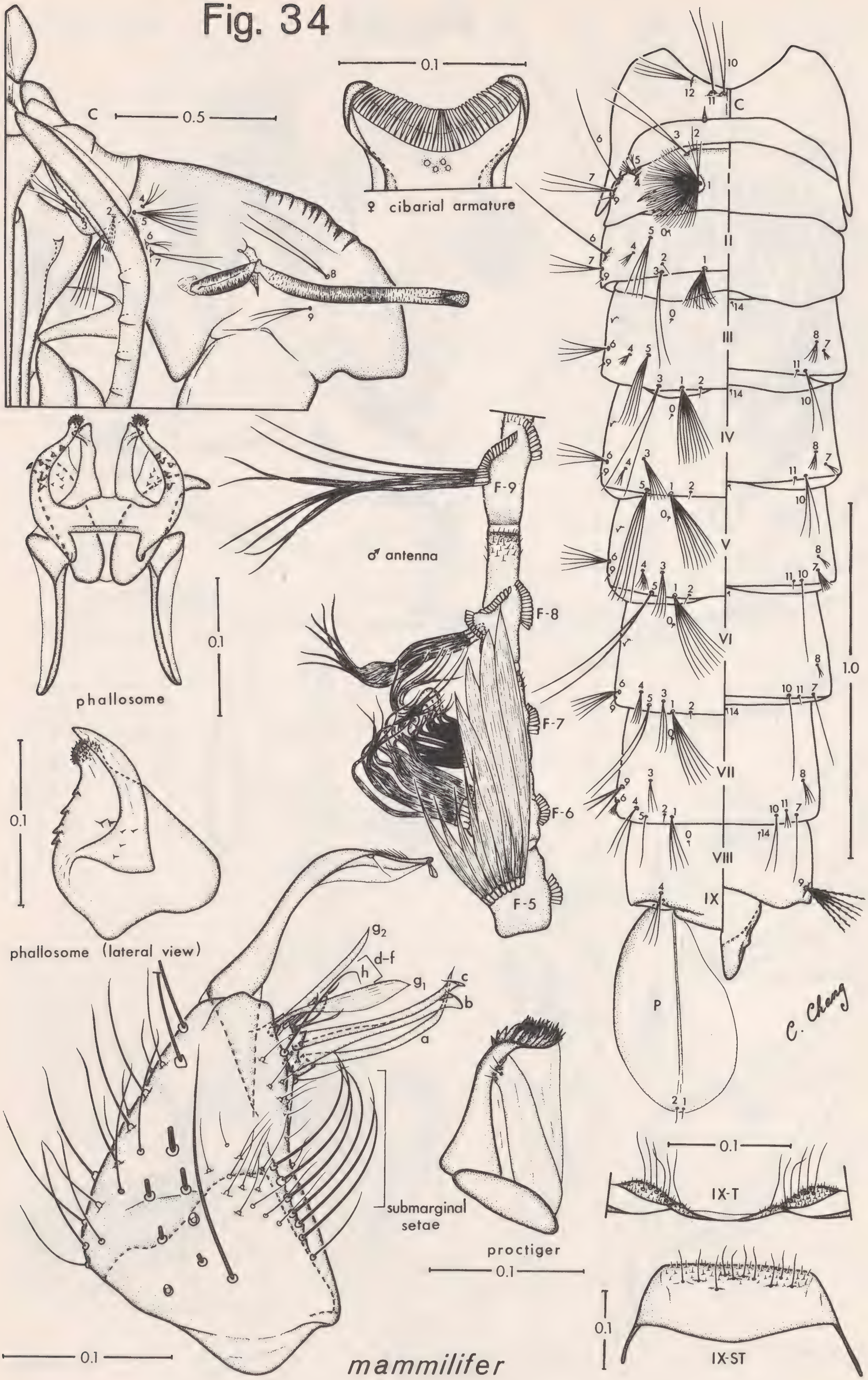
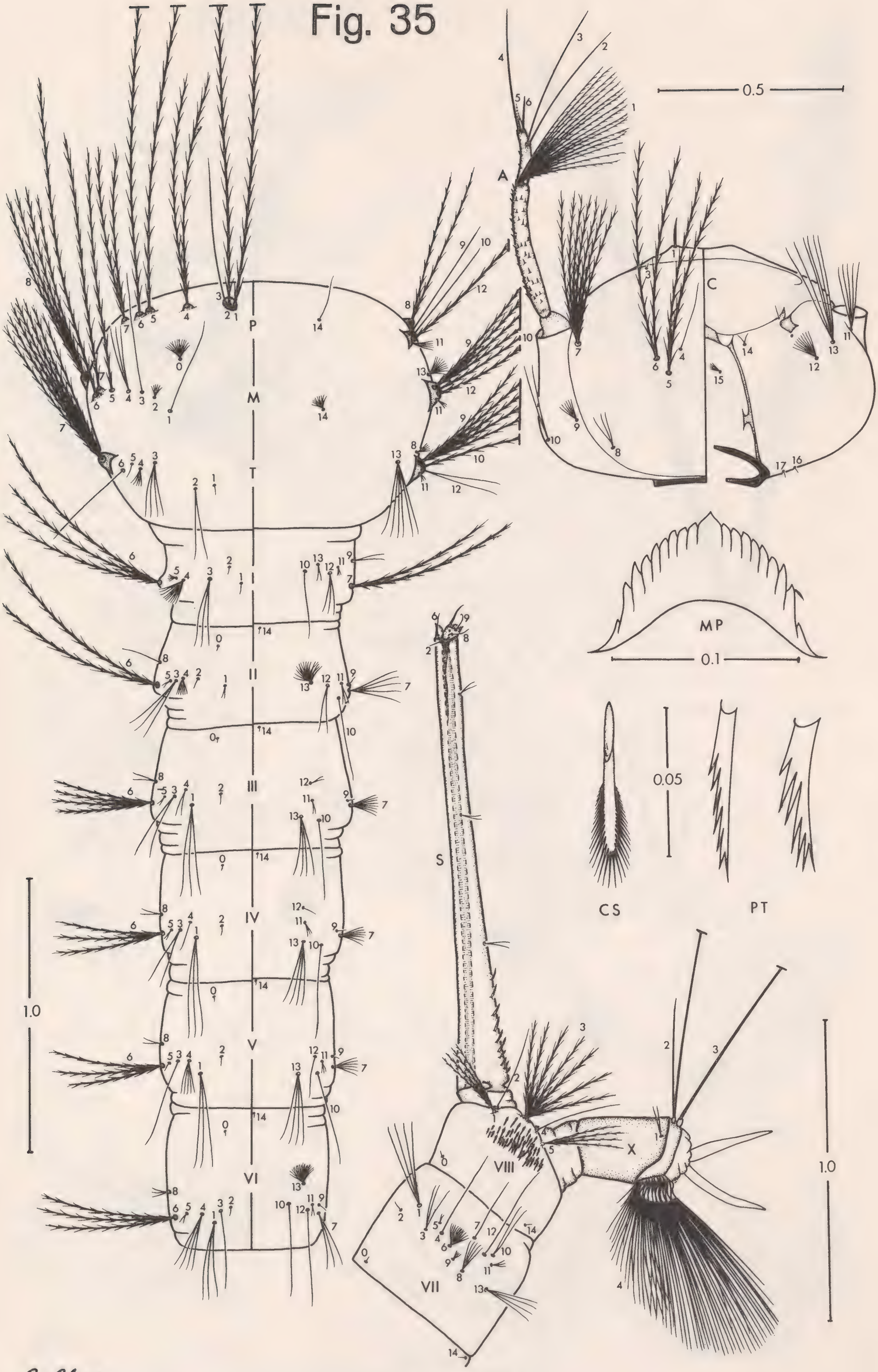

C
0.5
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♀ cibarial armature
10
12
11
C
6
3
2
5
4
7
9
1
II
III
IV
V
VI
VII
VIII
IX
14
0
8
F-9
♂ antenna
F-8
F-7
F-6
F-5
phallosome
phallosome (lateral view)
g_2
d-f
h
g_1
c
b
a
submarginal setae
proctiger
P
2 1
IX-T
IX-ST
C. Chang
mammilifer

Fig. 35



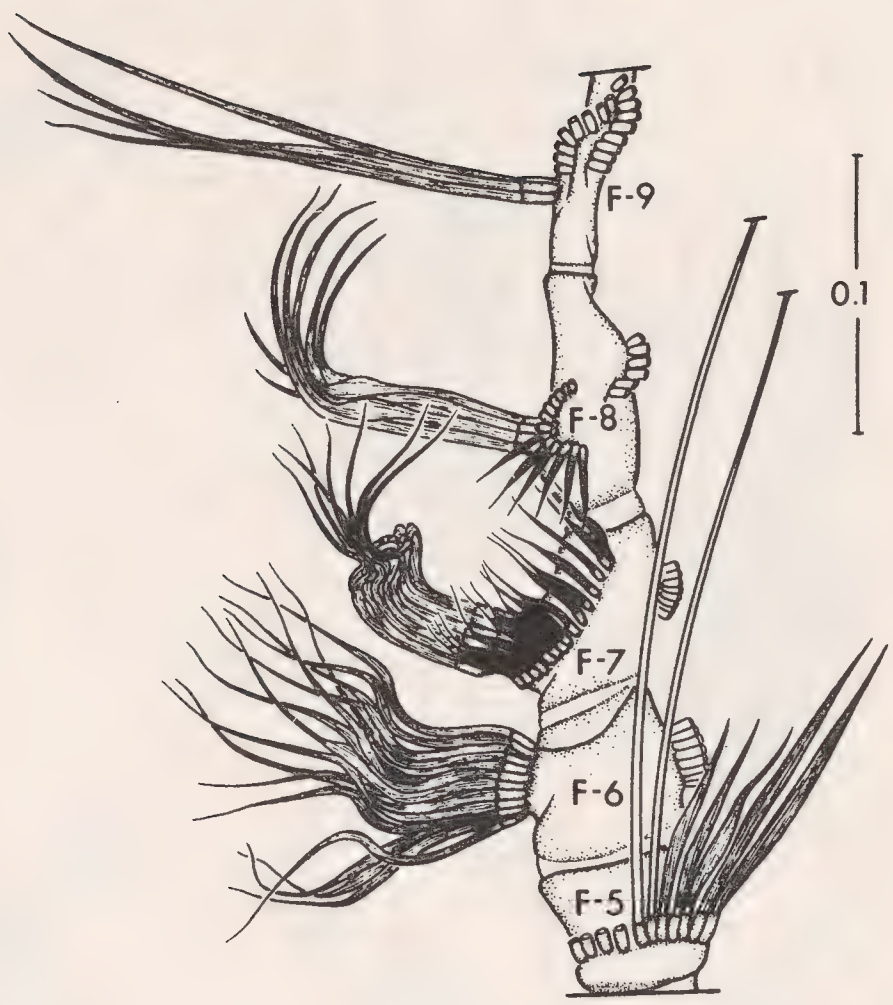
C. Chang

mammilifer

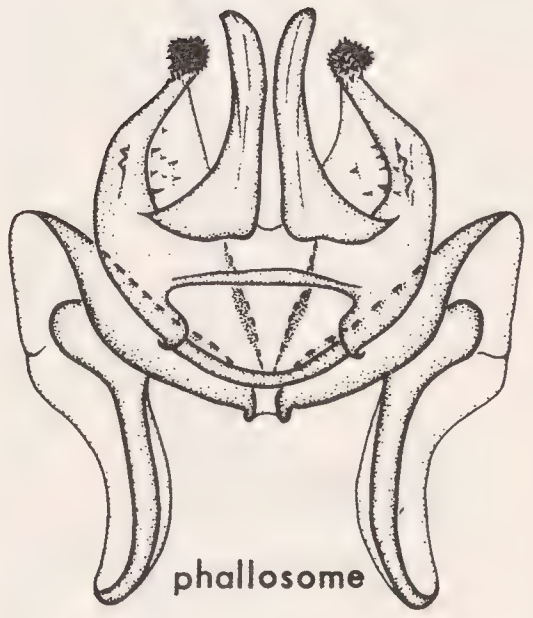
Fig. 36



♂ palpus & proboscis



♂ antenna



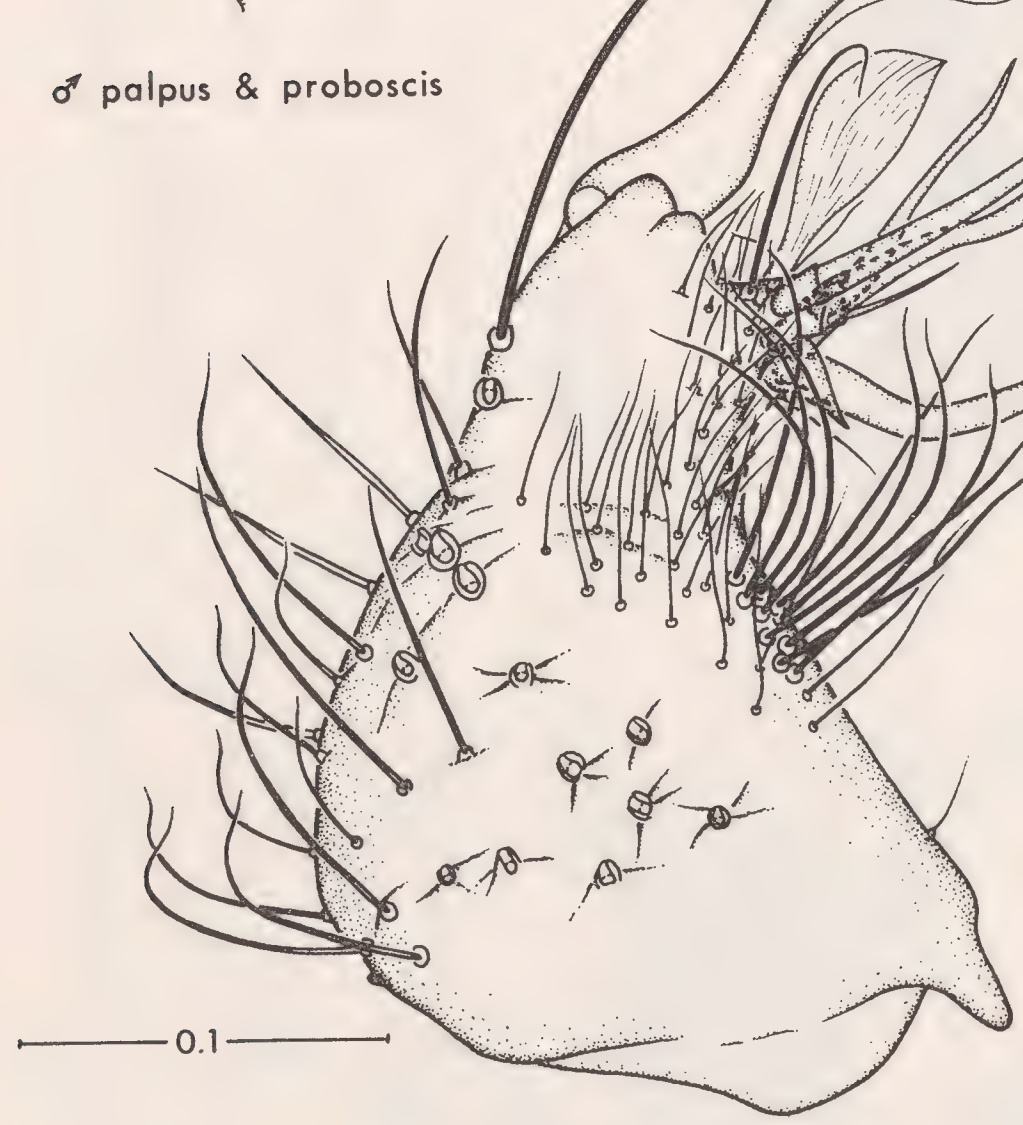
phallosome



phallosome (lateral view)

0.1

proctiger



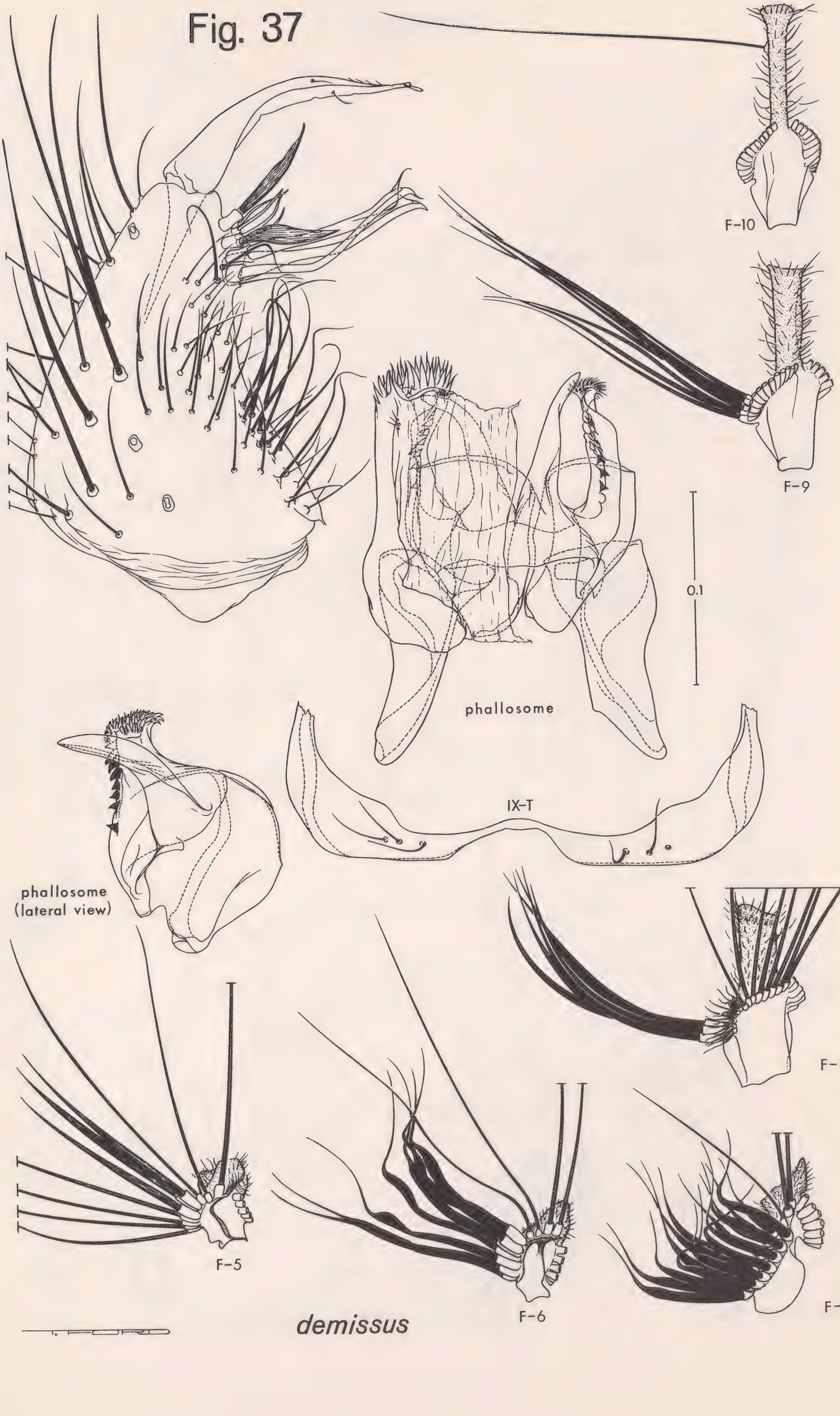
IX-ST

IX-T

wardi

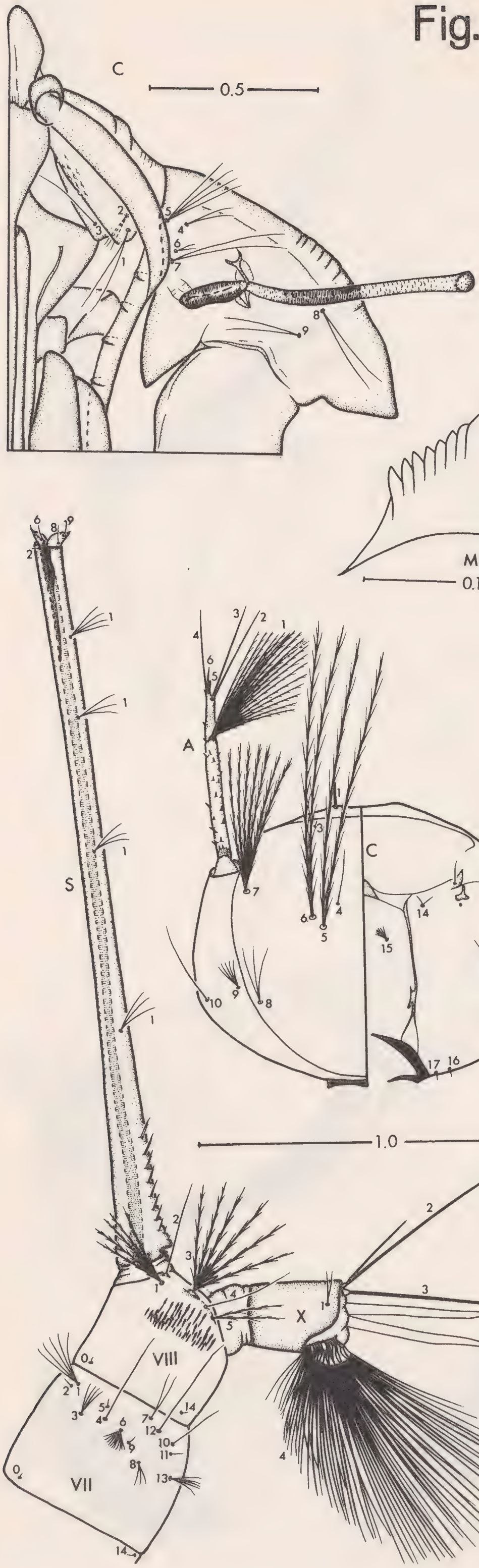
C. Clang

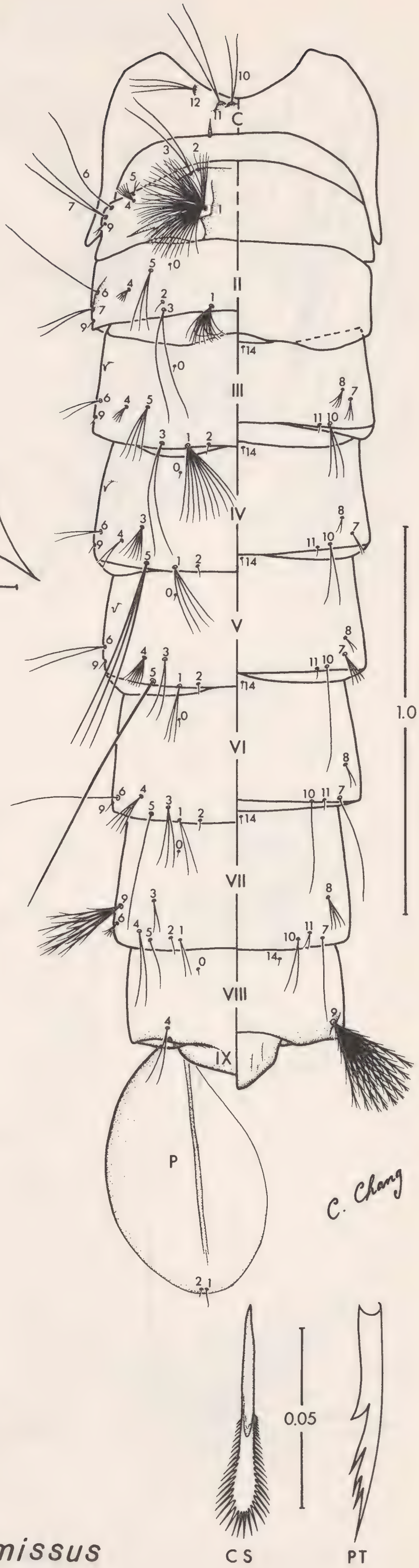
Fig. 37



demissus

Fig. 38





demissus

Fig. 39

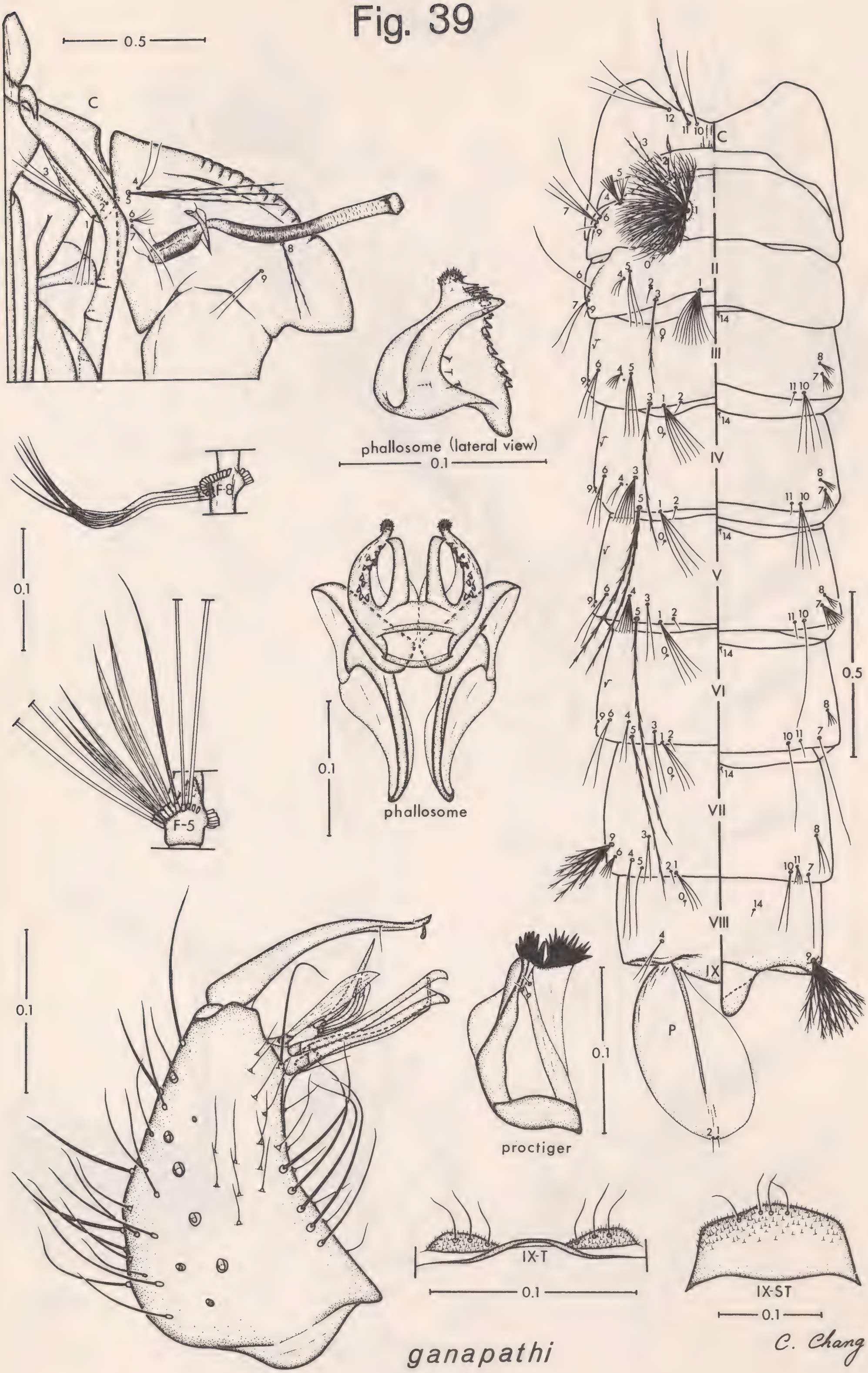

0.5
C
phallosome (lateral view)
0.1
F-8
0.1
F-5
0.1
phallosome
C
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III
IV
V
VI
VII
VIII
IX
P
0.5
0.1
proctiger
IX-T
0.1
IX-ST
0.1
ganapathi
C. Chang

Fig. 40

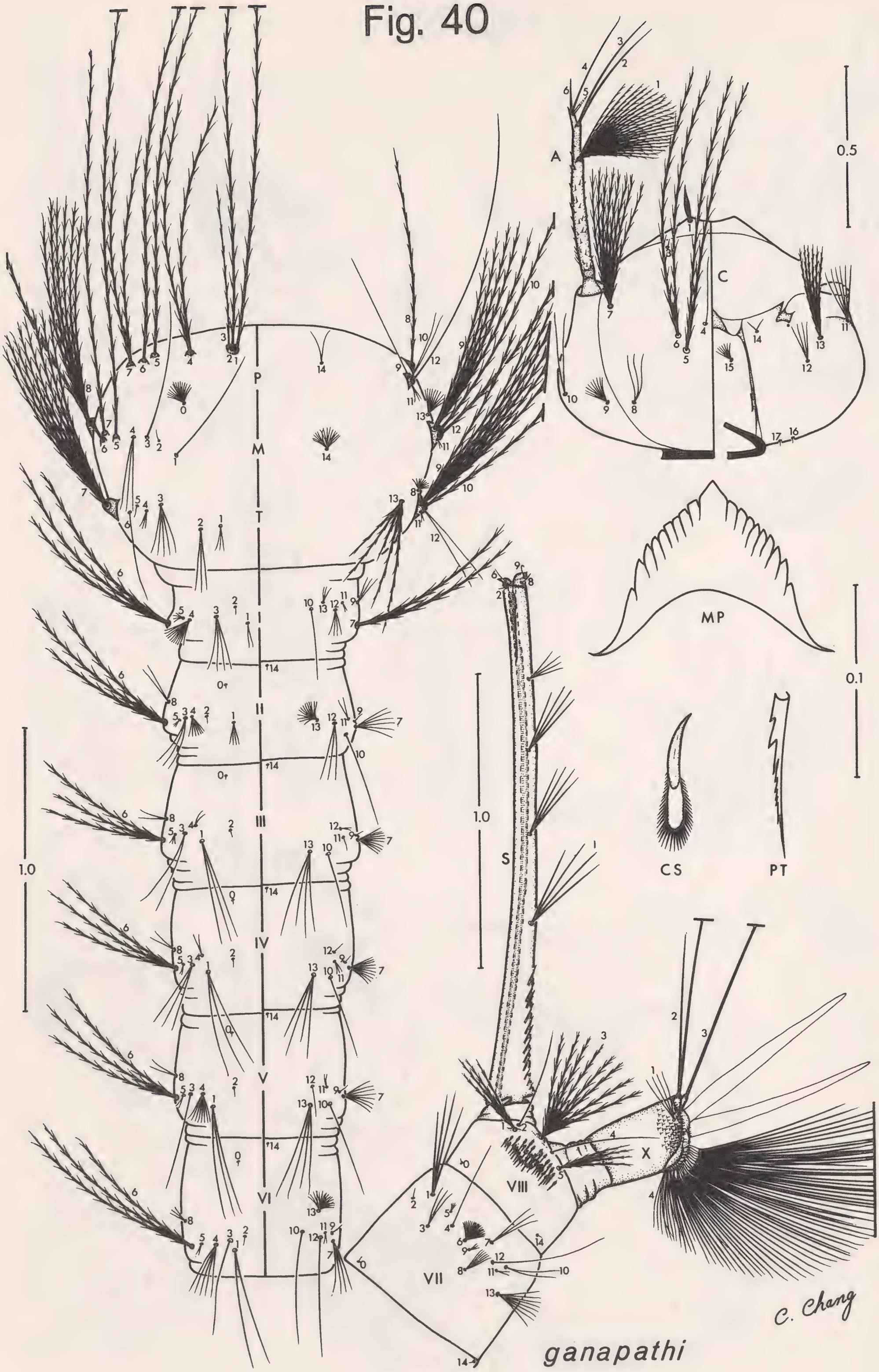
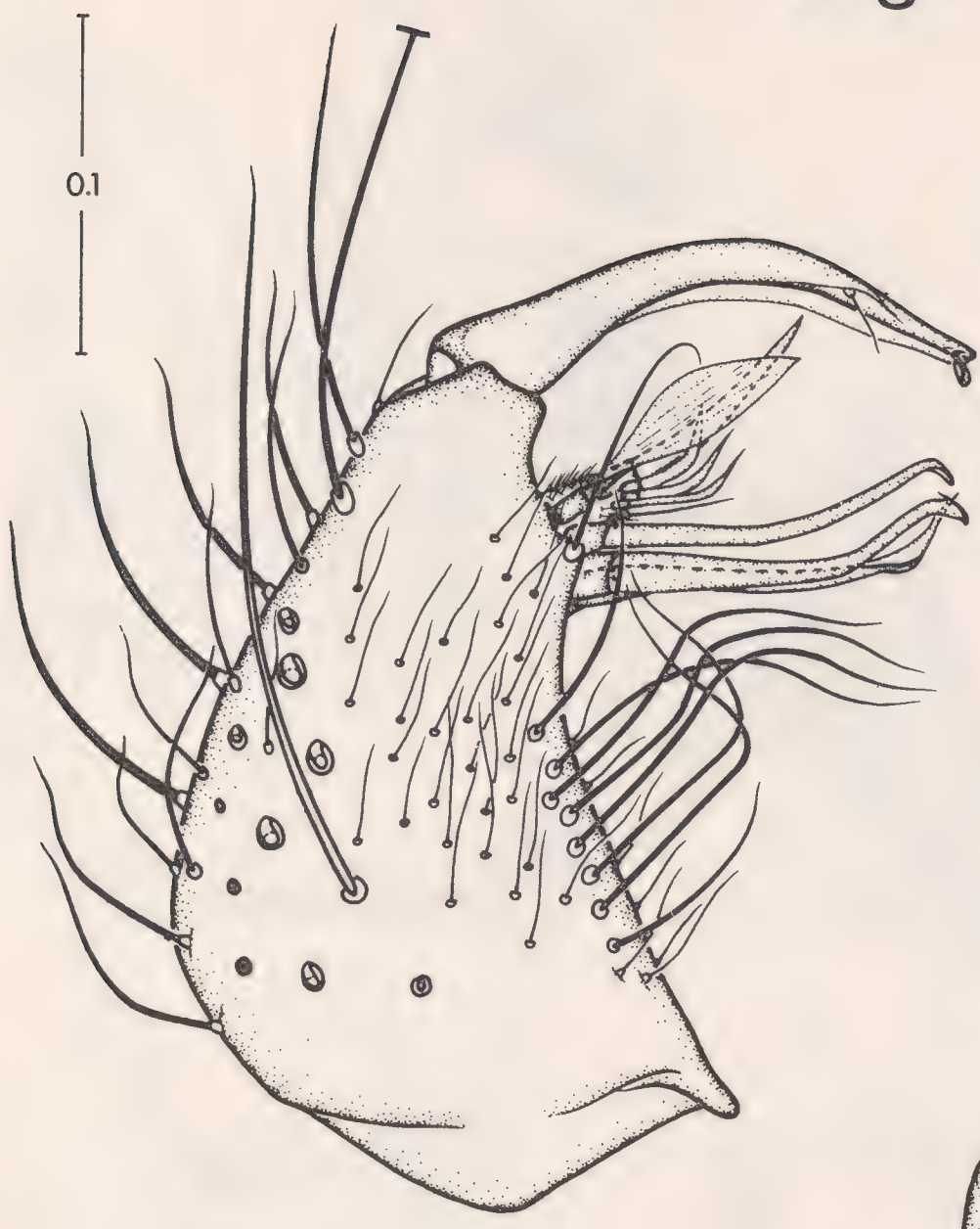
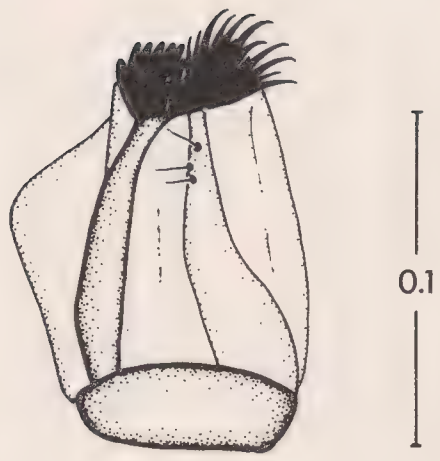
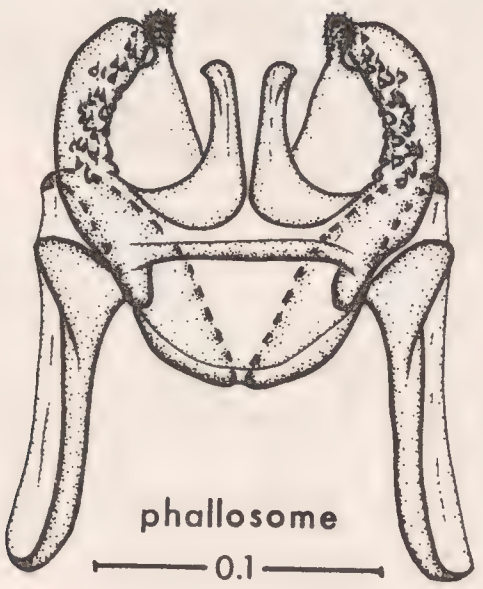

A
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VIII
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PT
0.5
0.1
1.0
1.0
ganapathi
C. Chang

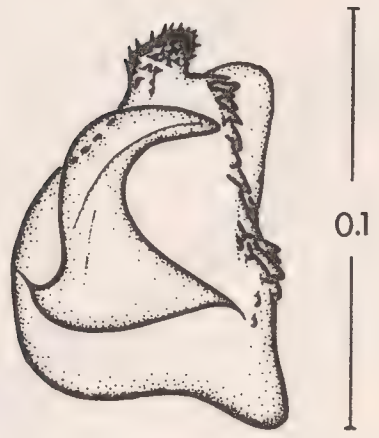
Fig. 41



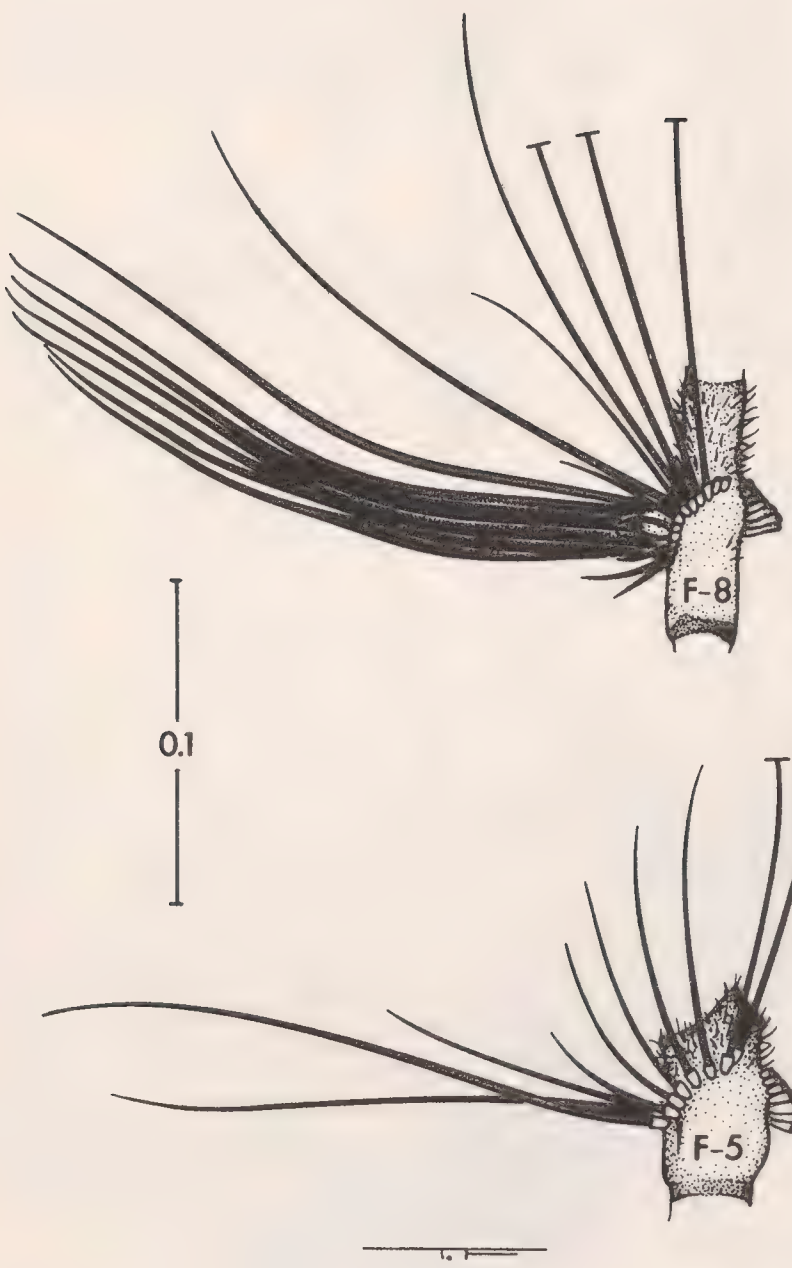


proctiger

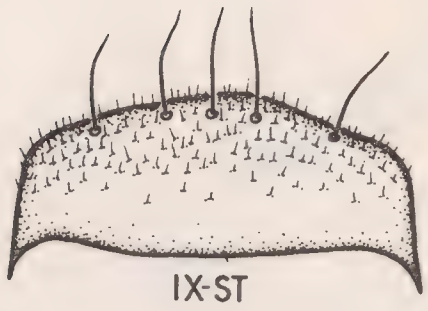




phallosome
(lateral view)



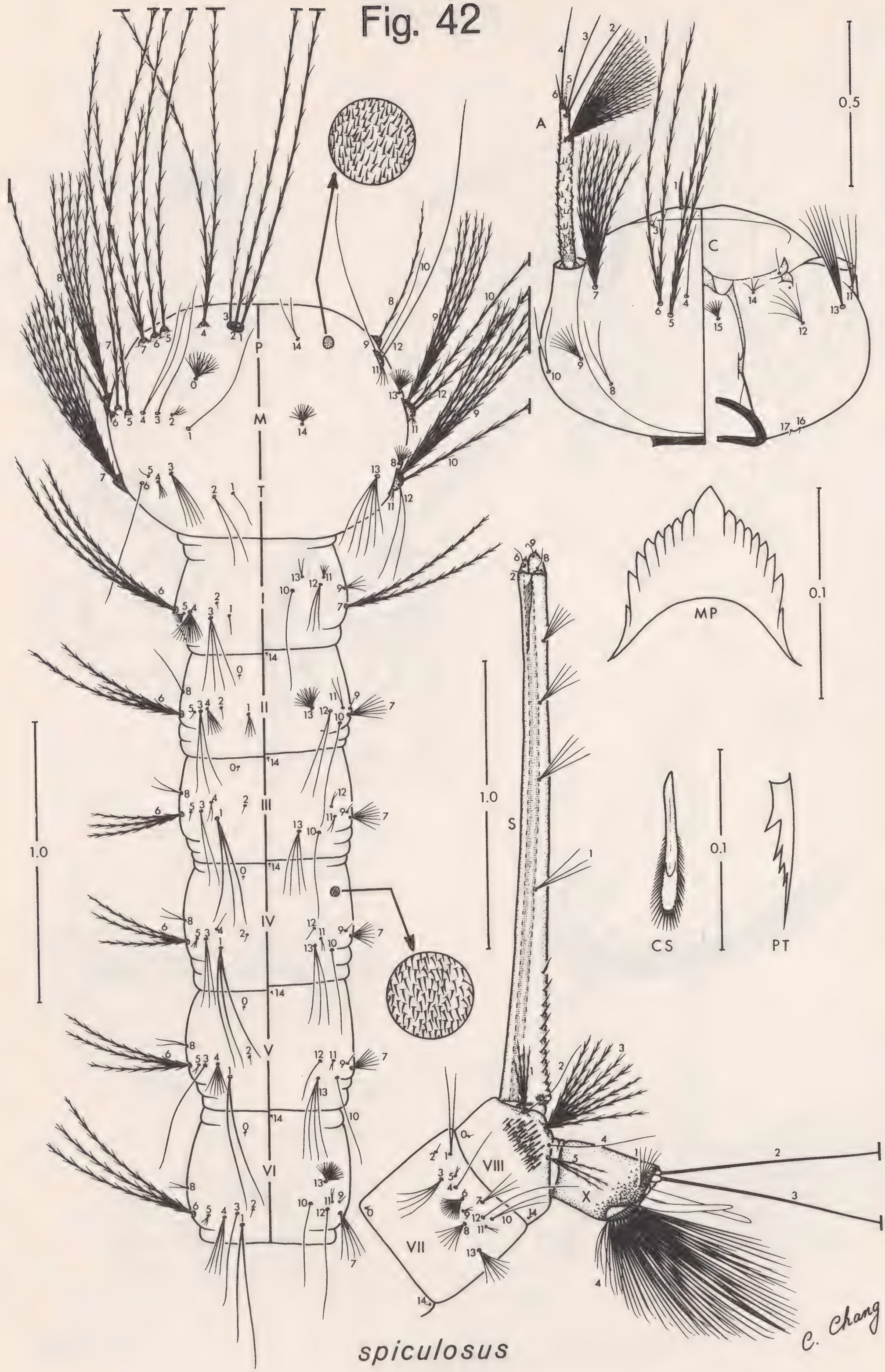




C. Chang

spiculosus

Fig. 42



spiculosus

C. Chang

Fig. 43

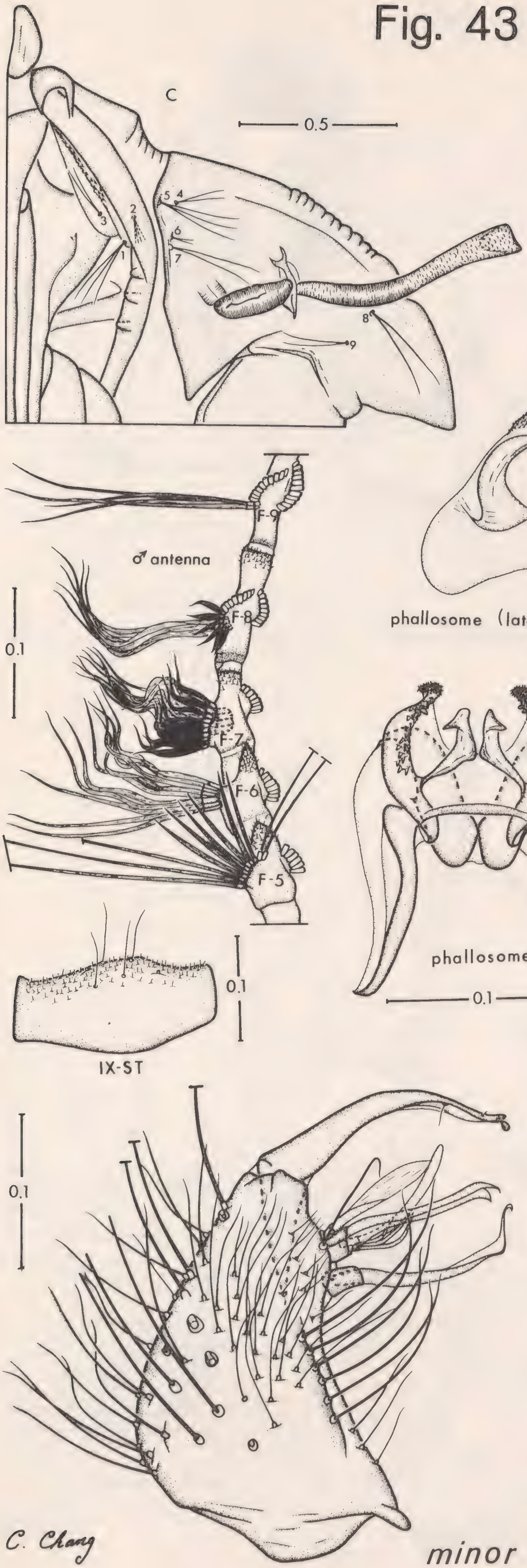

C
0.5
♂ antenna
F-9
F-8
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F-6
F-5
0.1
IX-ST
phallosome (lateral view)
phallosome
0.1
C
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proctiger
0.1
IX-T
0.1
C. Chang
minor

Fig. 44

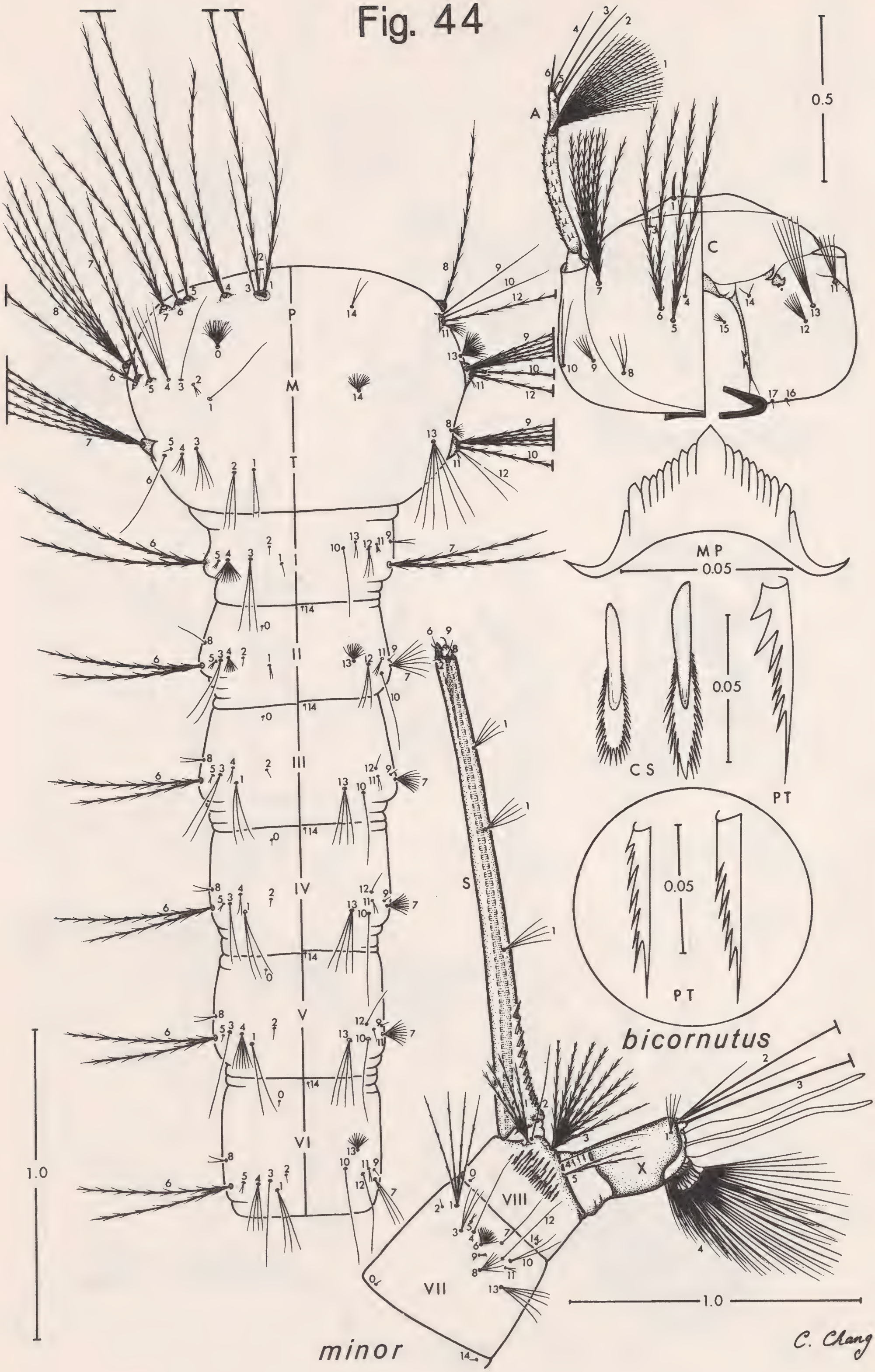
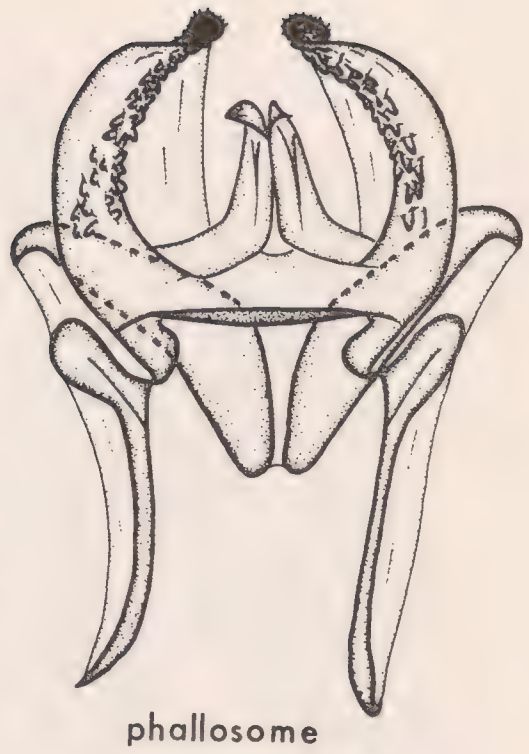

A
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1.0
bicornutus
minor
C. Chang

Fig. 45

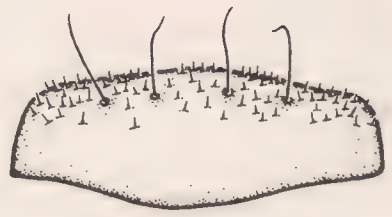



phallosome (lateral view)

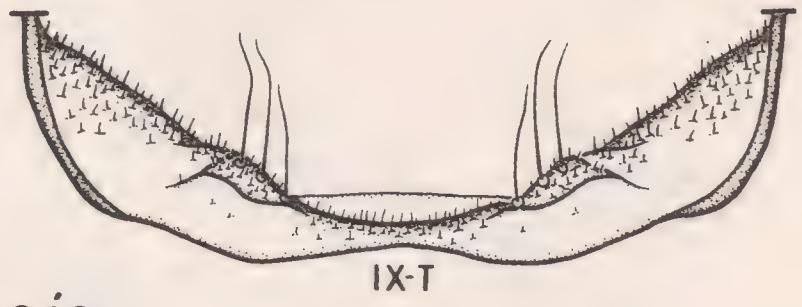

phallosome

0.1

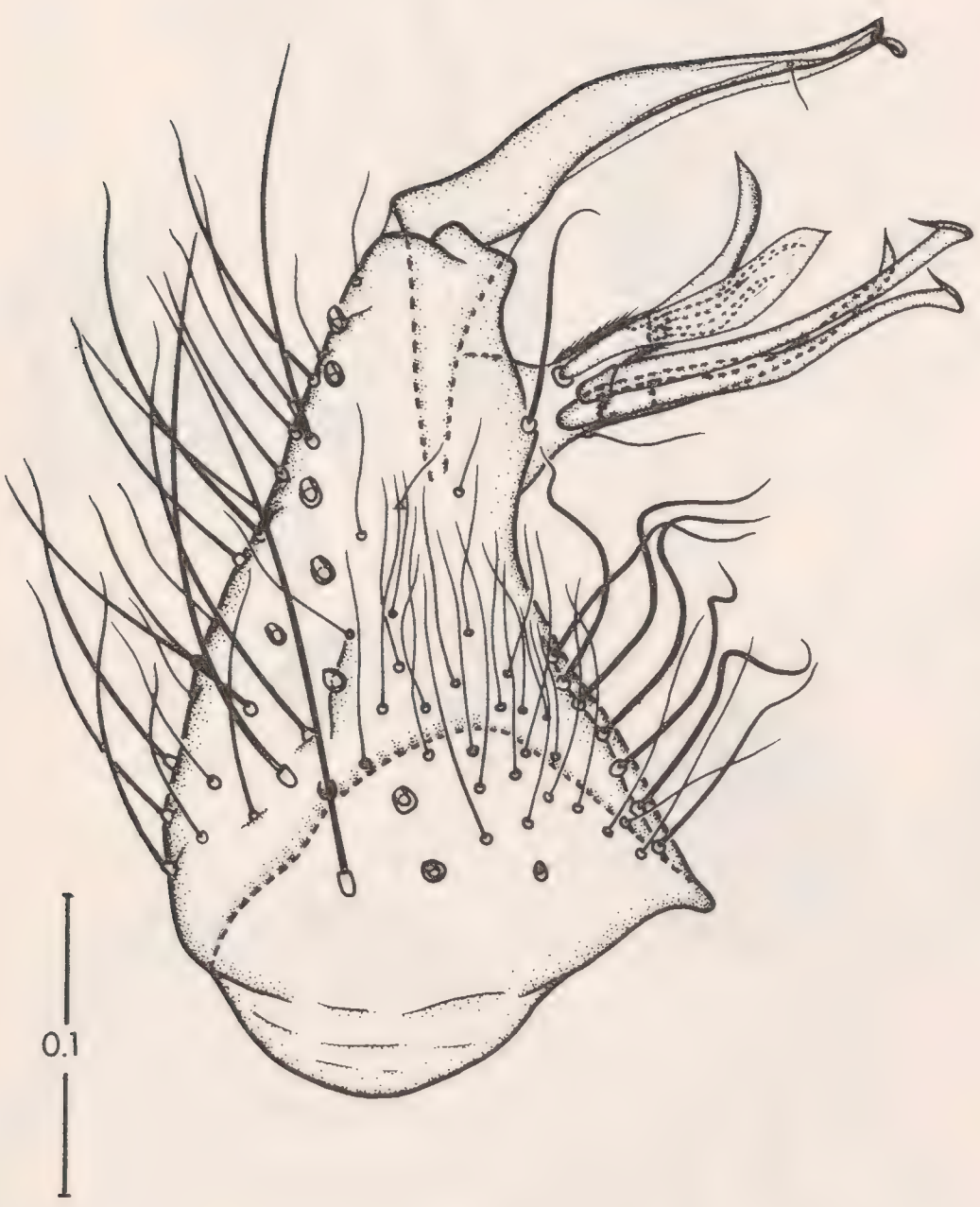

proctiger


IX-ST

0.1


IX-T

bandoengensis

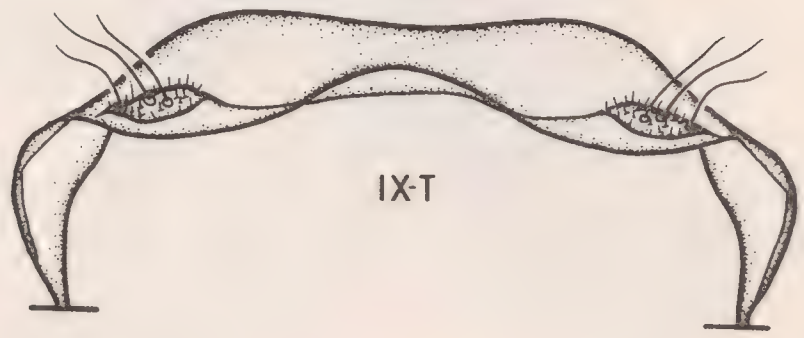



phallosome (lateral view)

0.1


proctiger

0.1

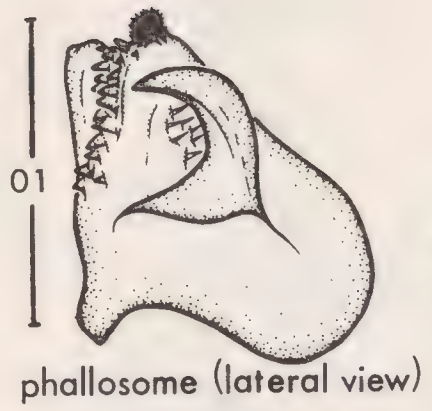


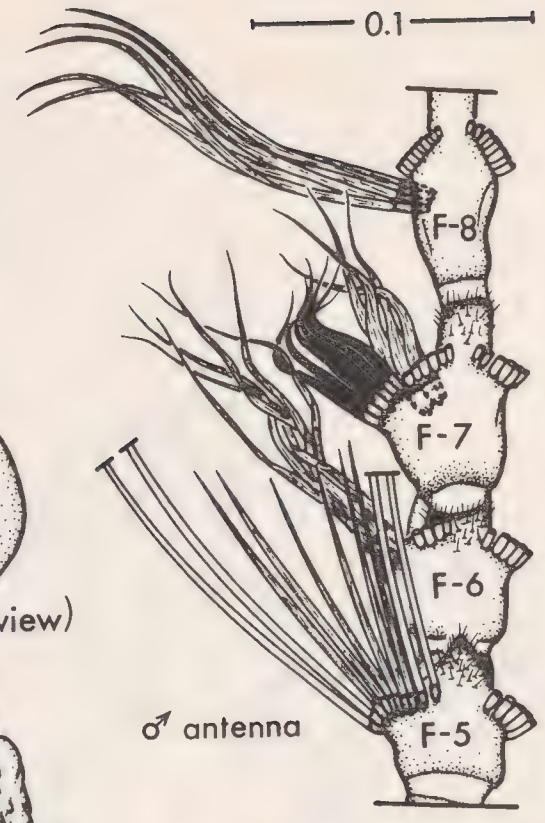
tuberis

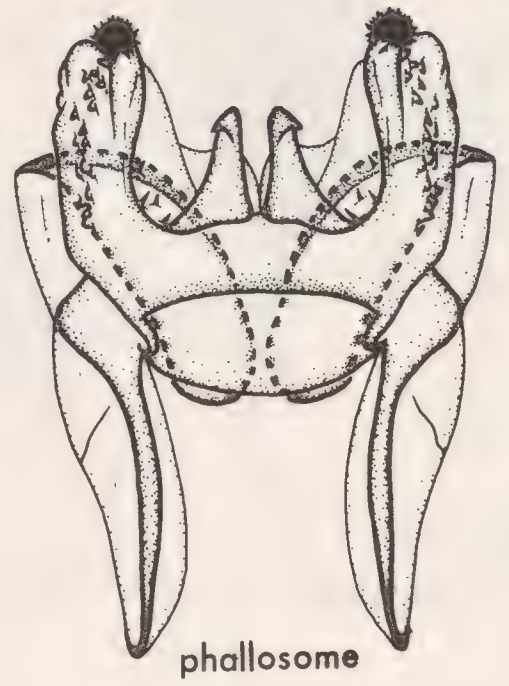
C. Chang

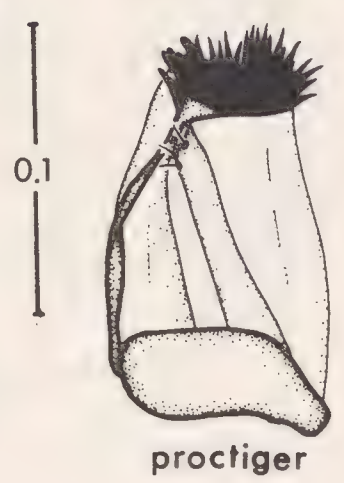
Fig. 46

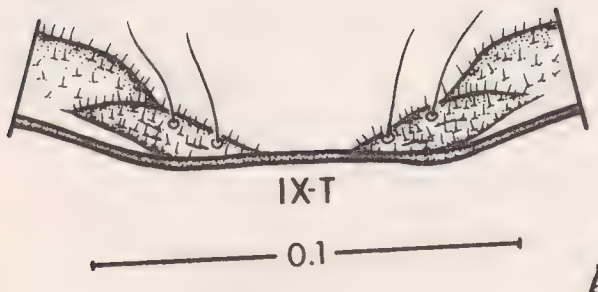


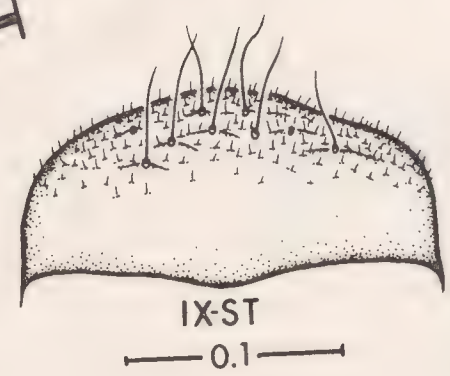




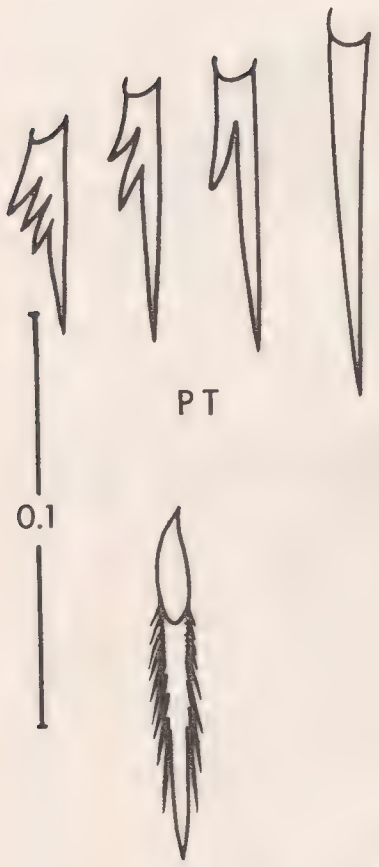


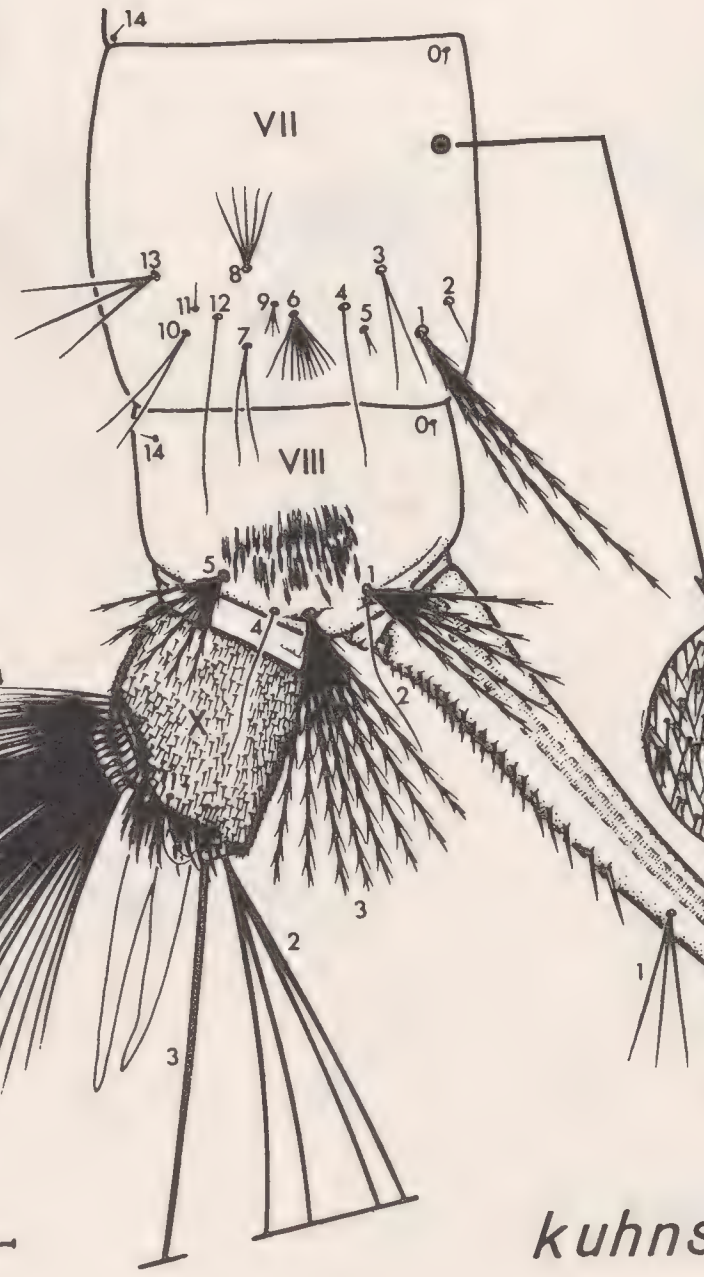












kuhnsi

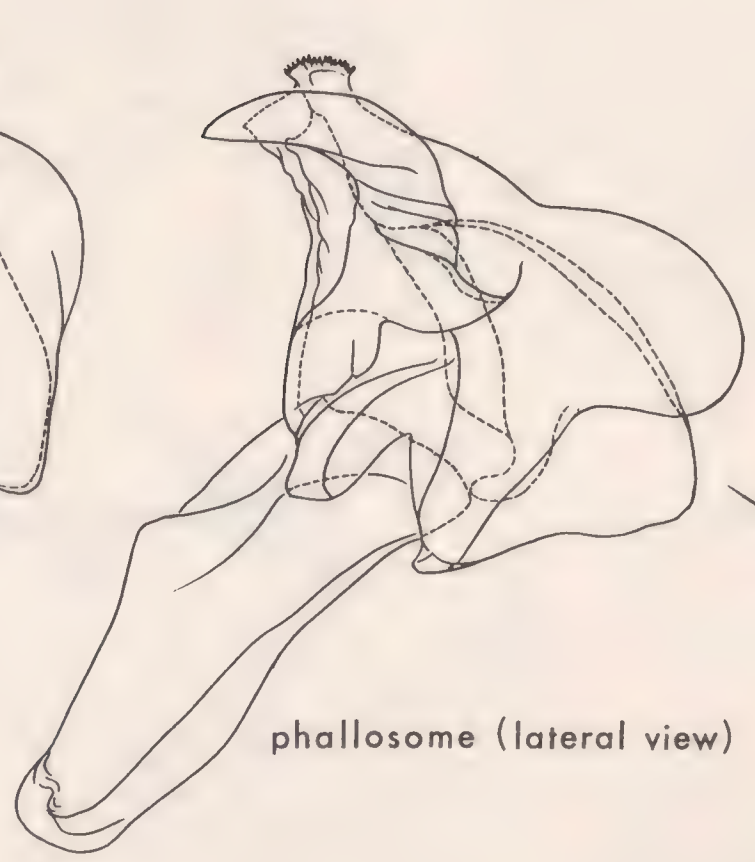
C. Chang

Fig. 47

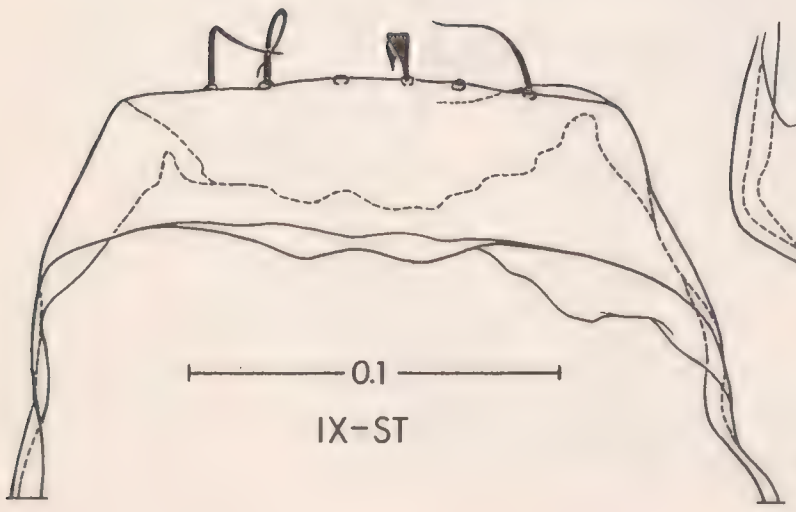


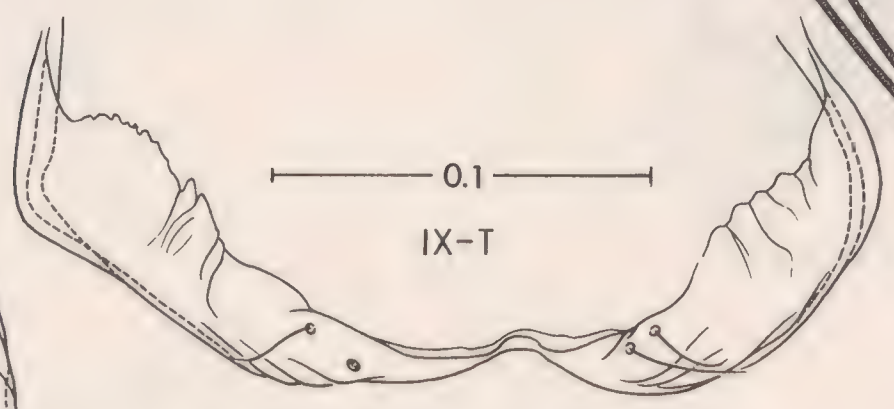


proctiger



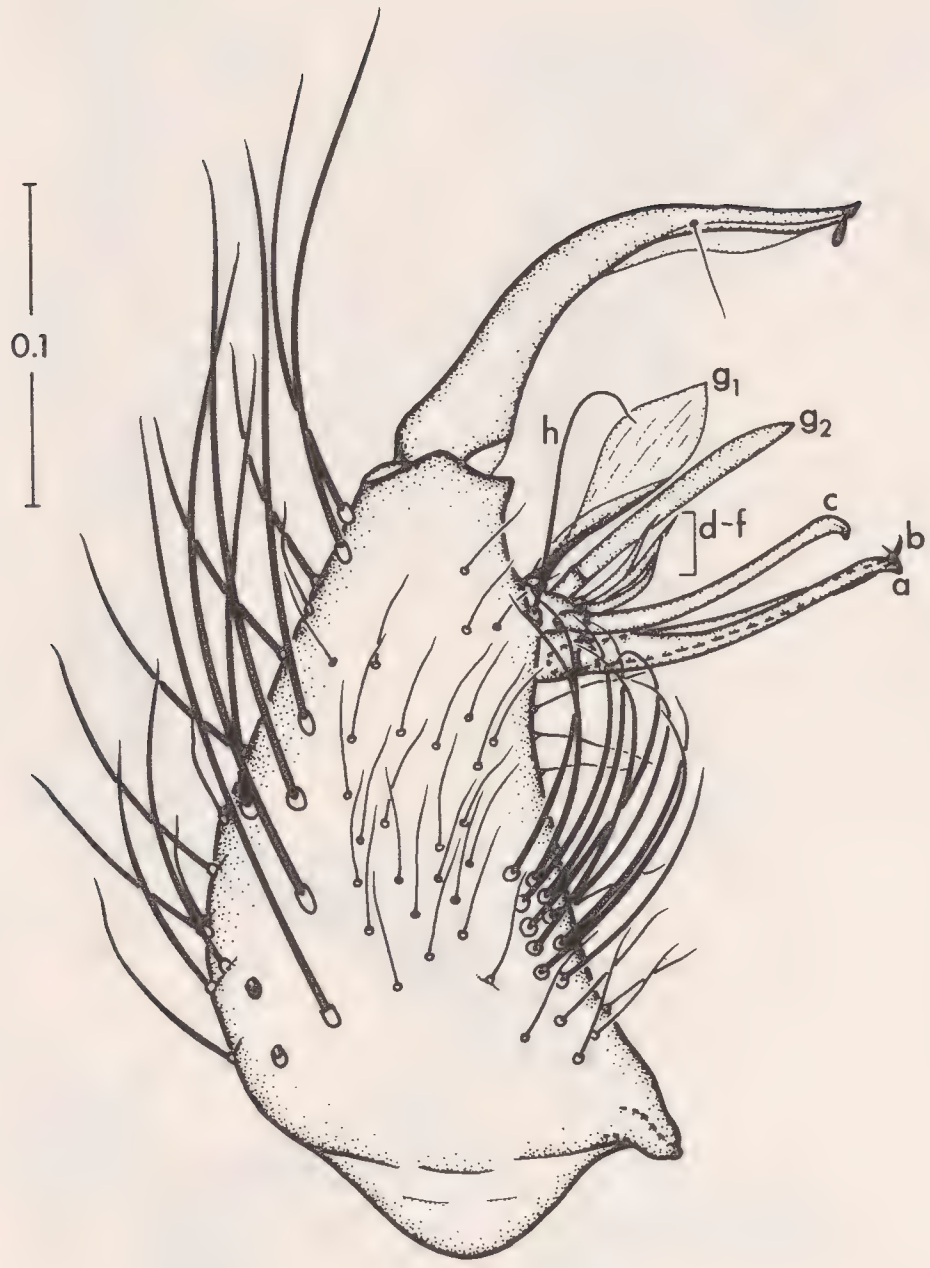
phallosome (lateral view)





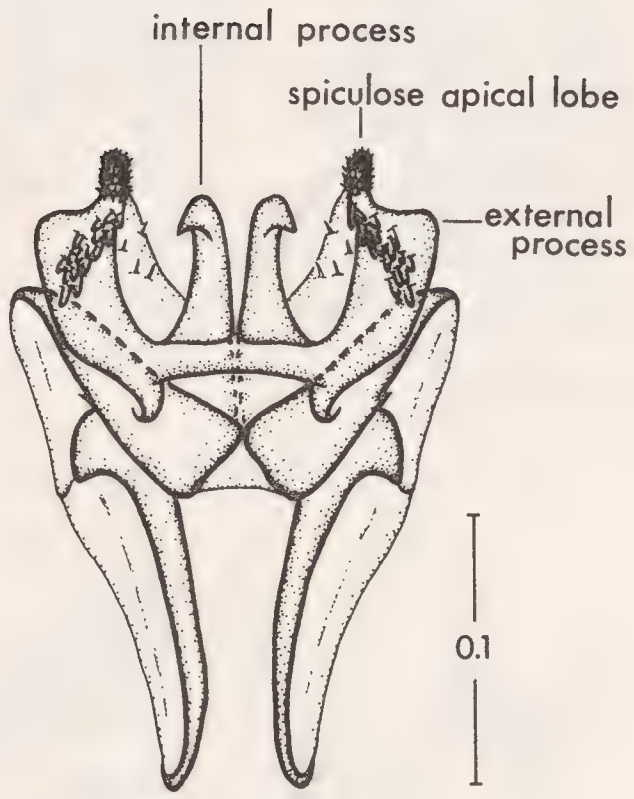
crassicomus

Fig. 48



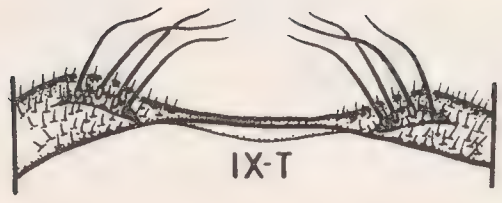


proctiger

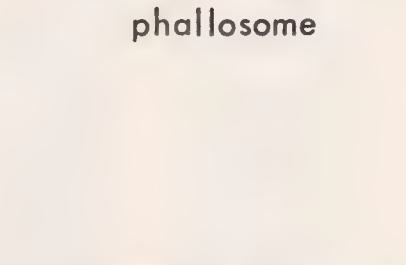


phallosome

♂ antenna



IX-T

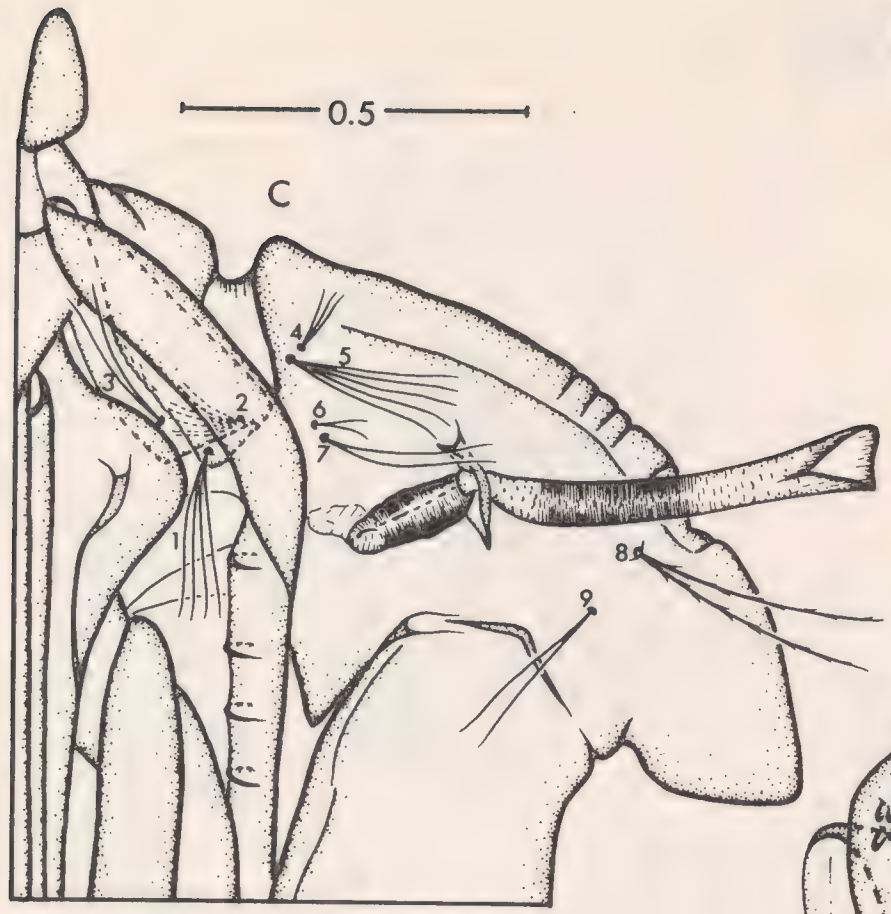


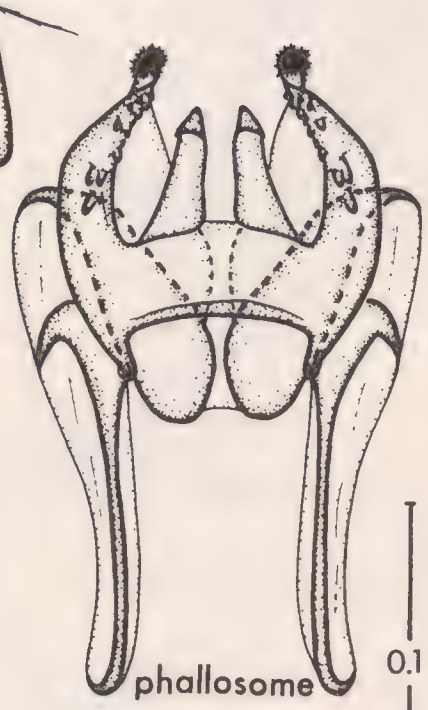
IX-ST

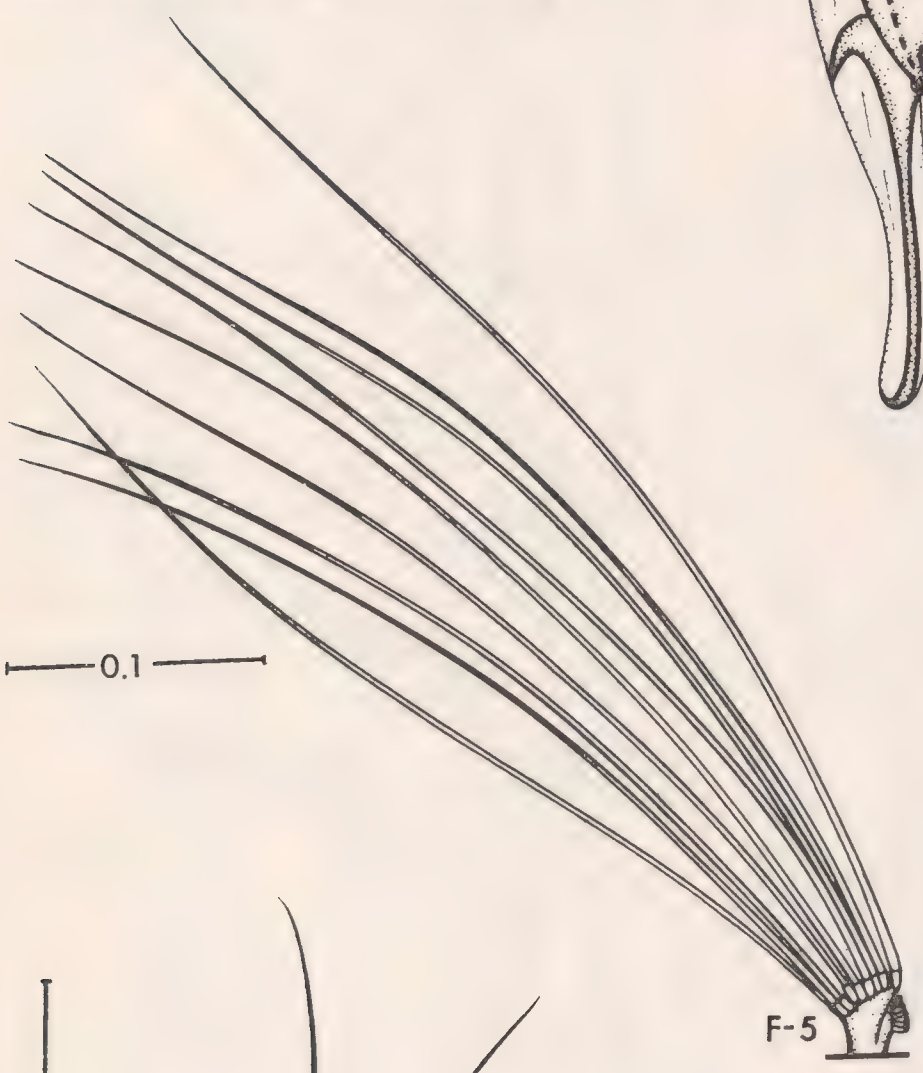
C. Chang

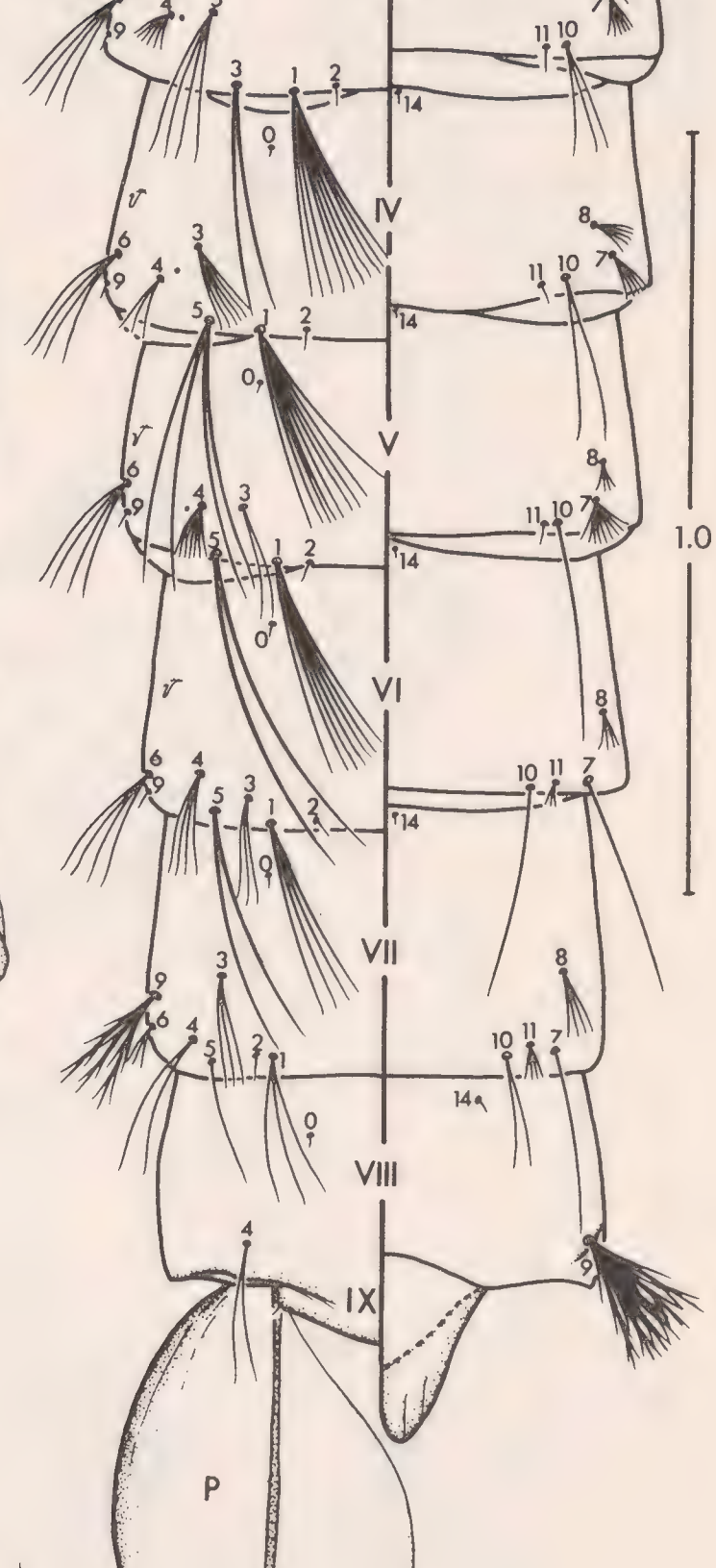
incomptus

Fig. 49

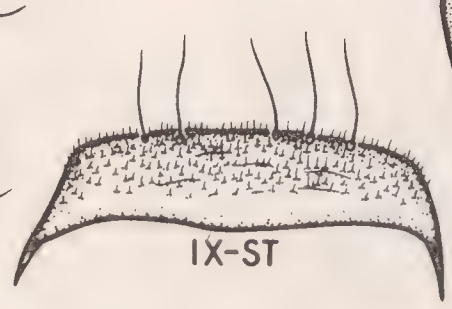


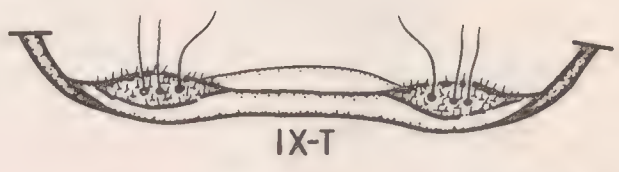








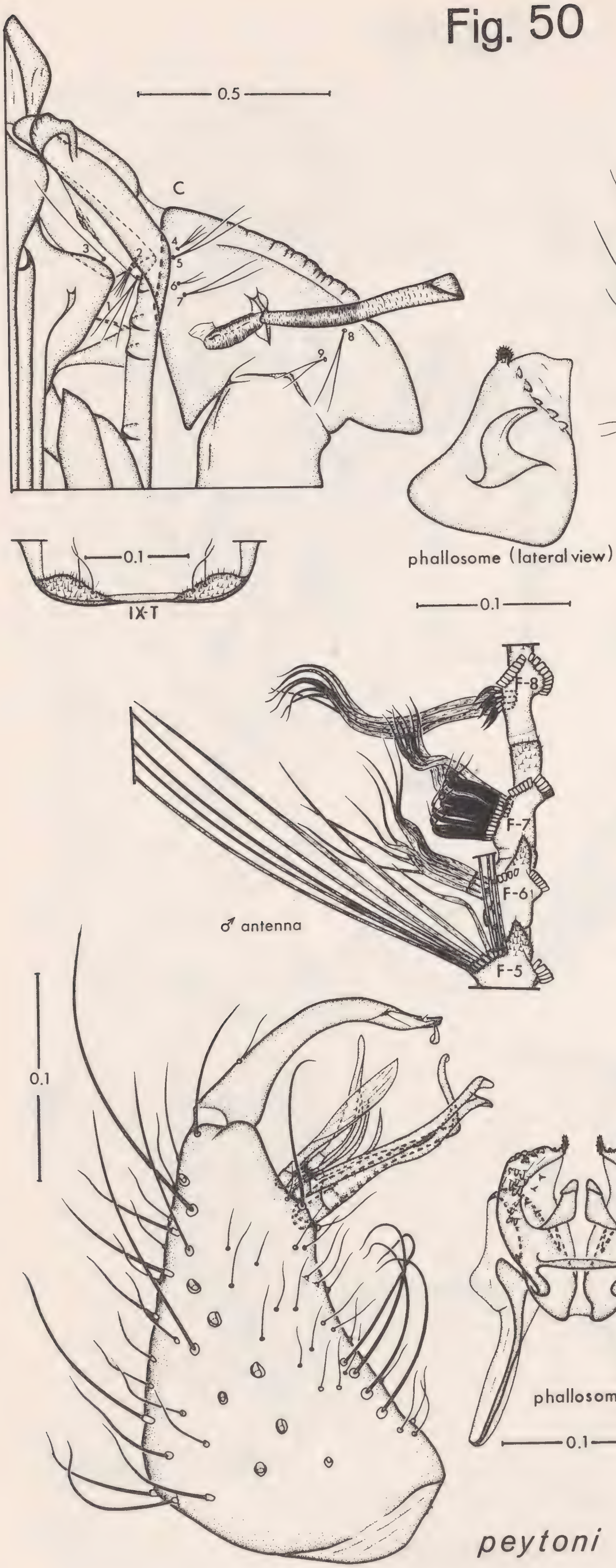


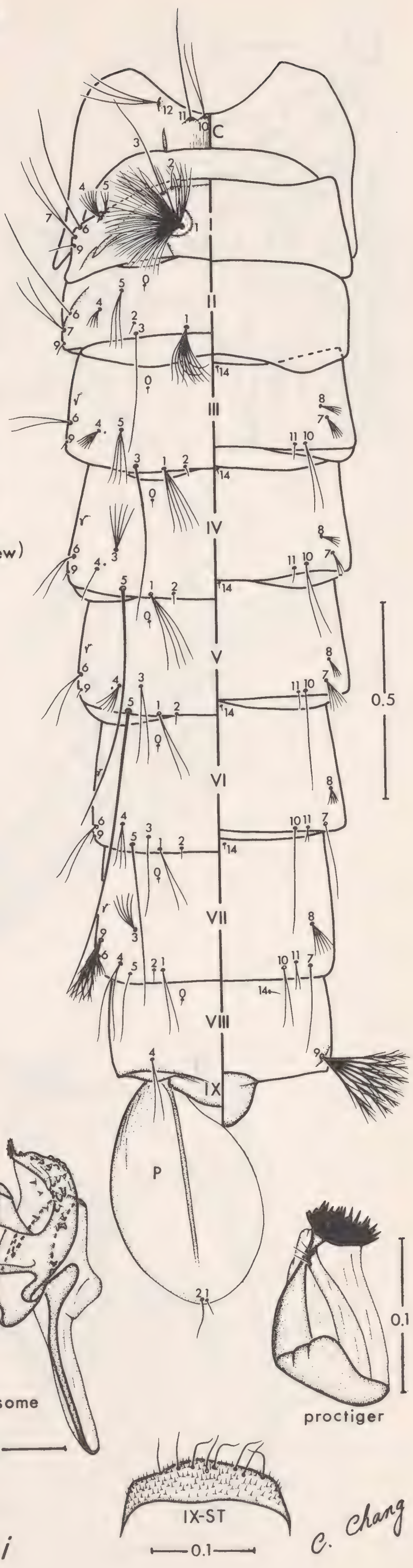


bengalensis

C. Chang

Fig. 50





peytoni

C. Chang

Fig. 51

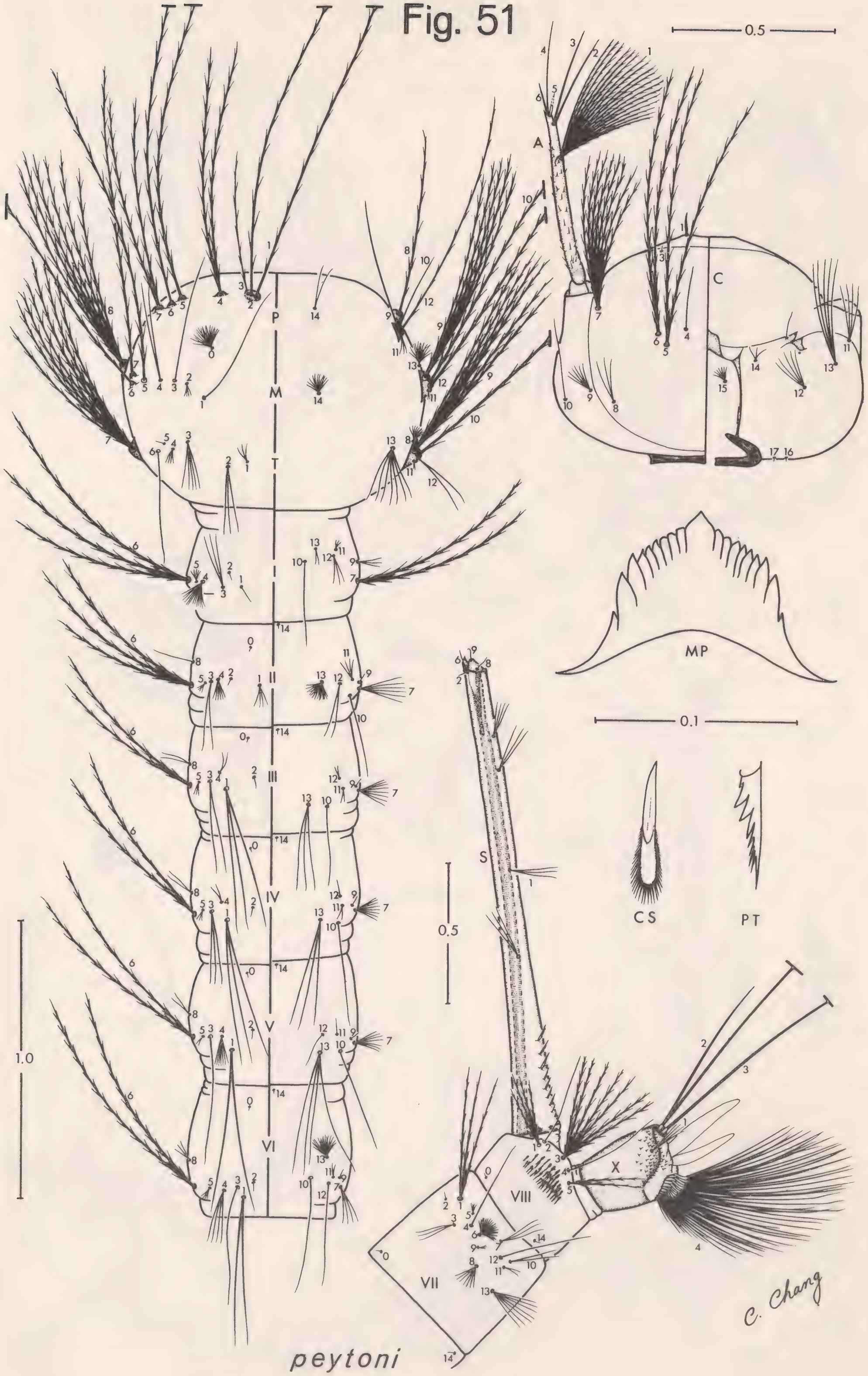
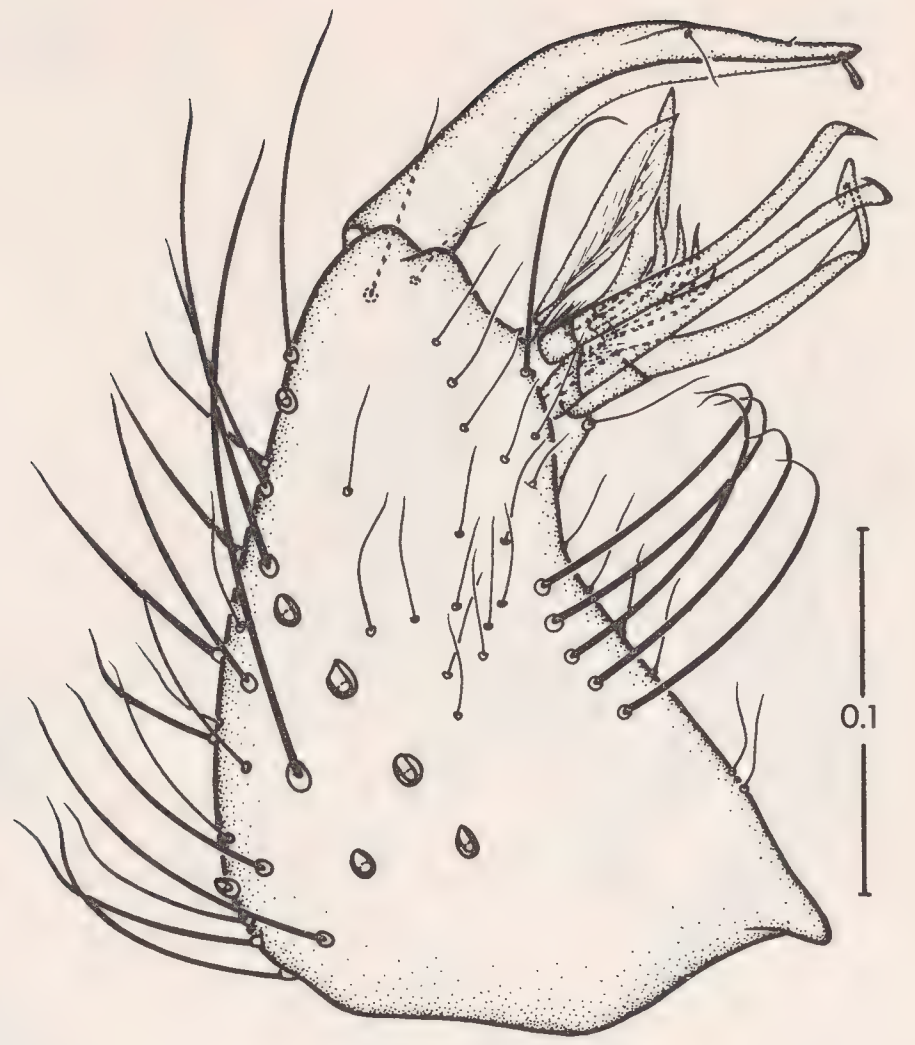
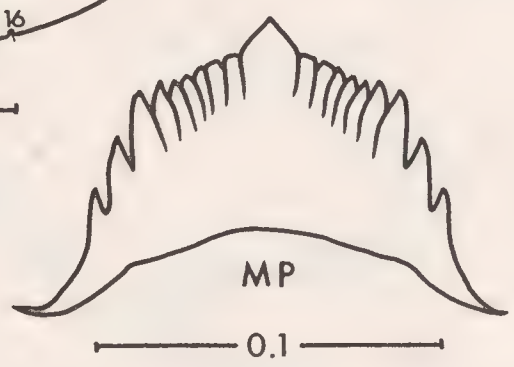
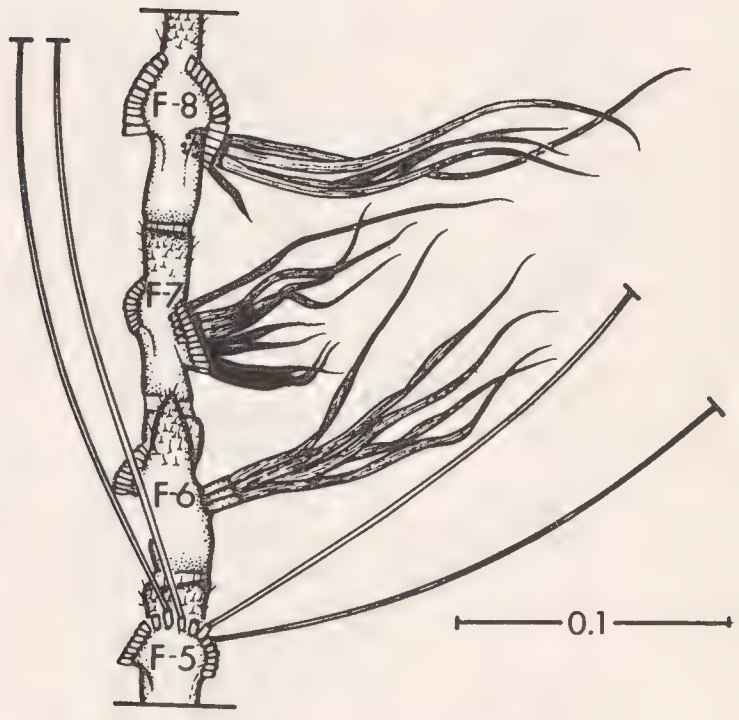

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0.5
1.0
peytoni
C. Chang

Fig. 52

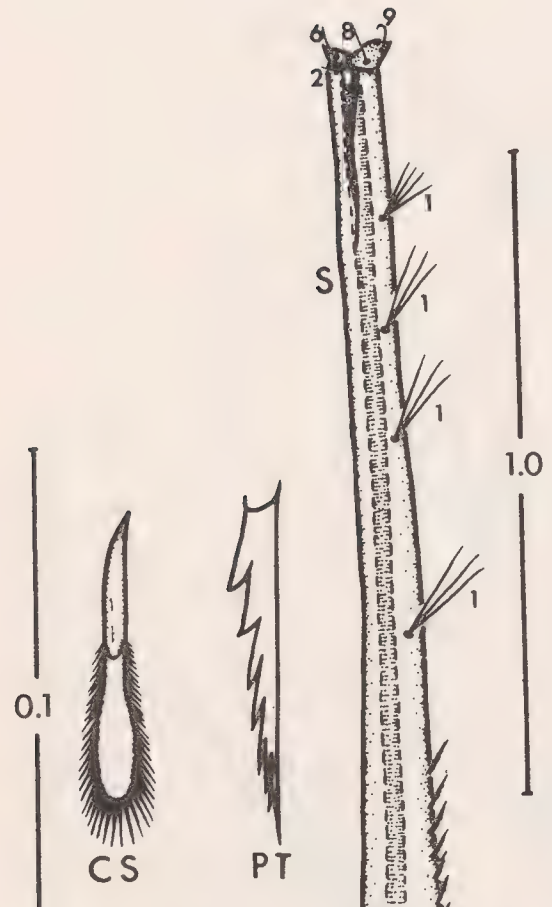


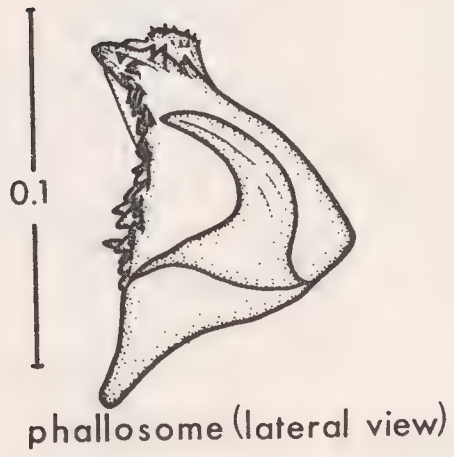




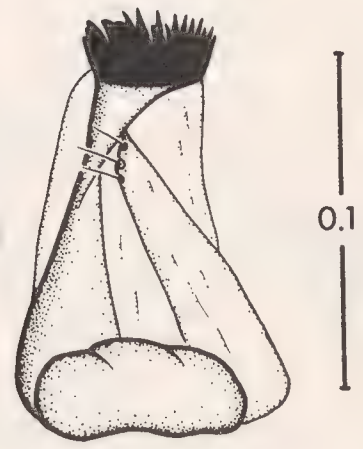


♂ antenna

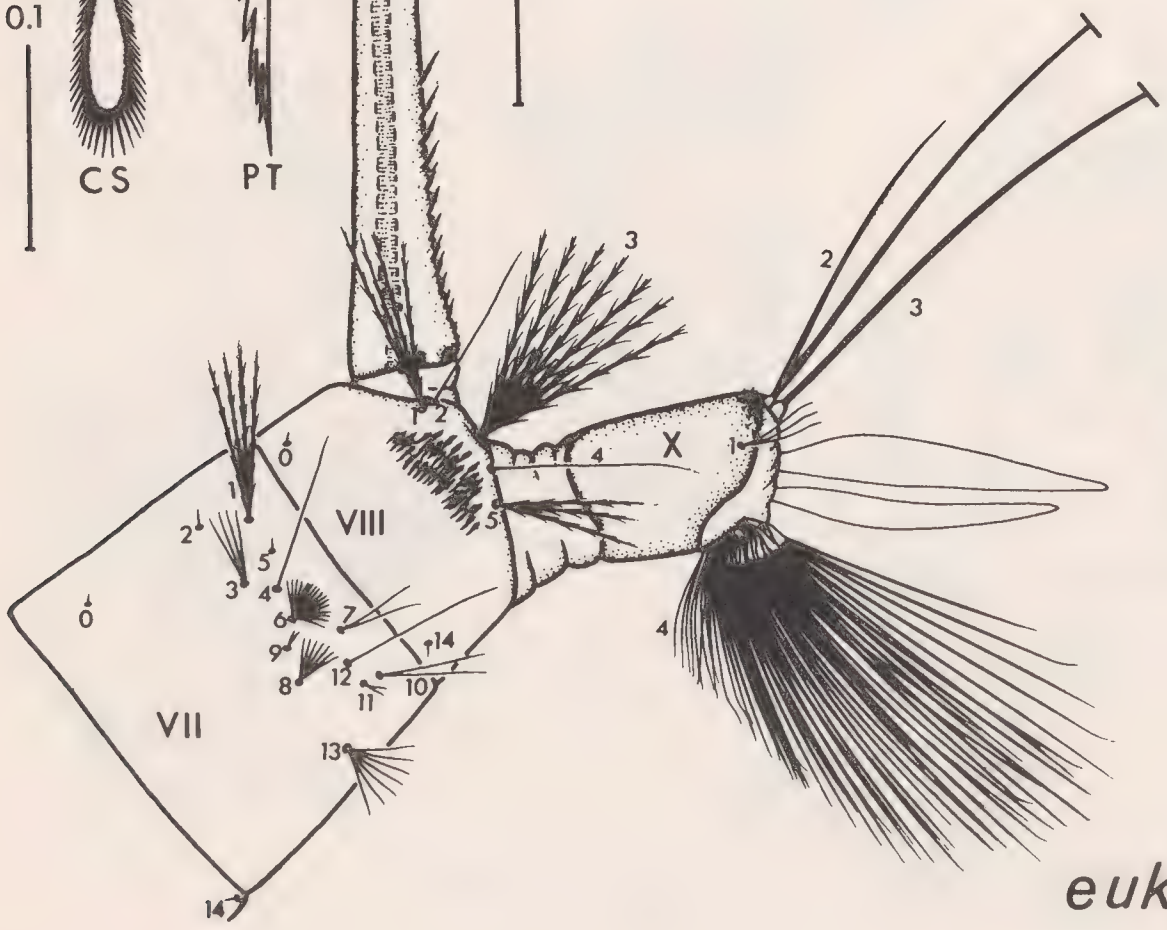




phallosome (lateral view)



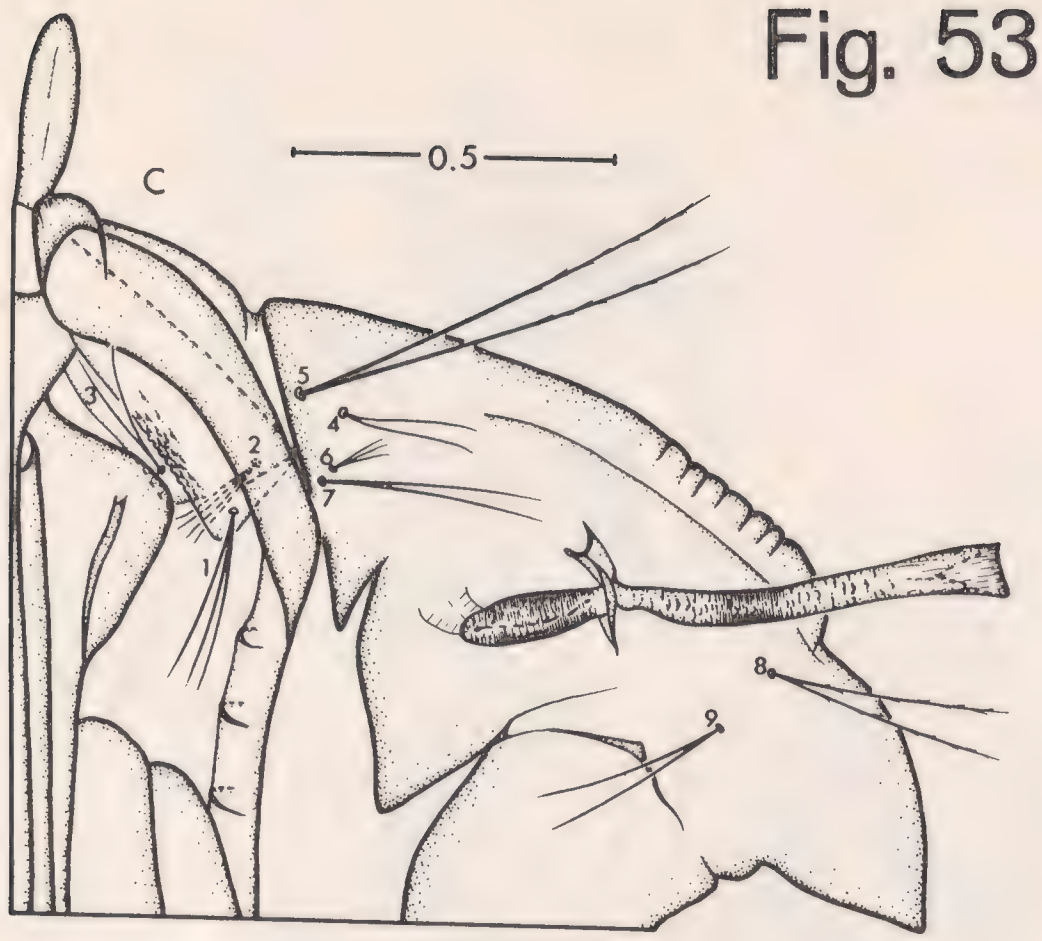
proctiger

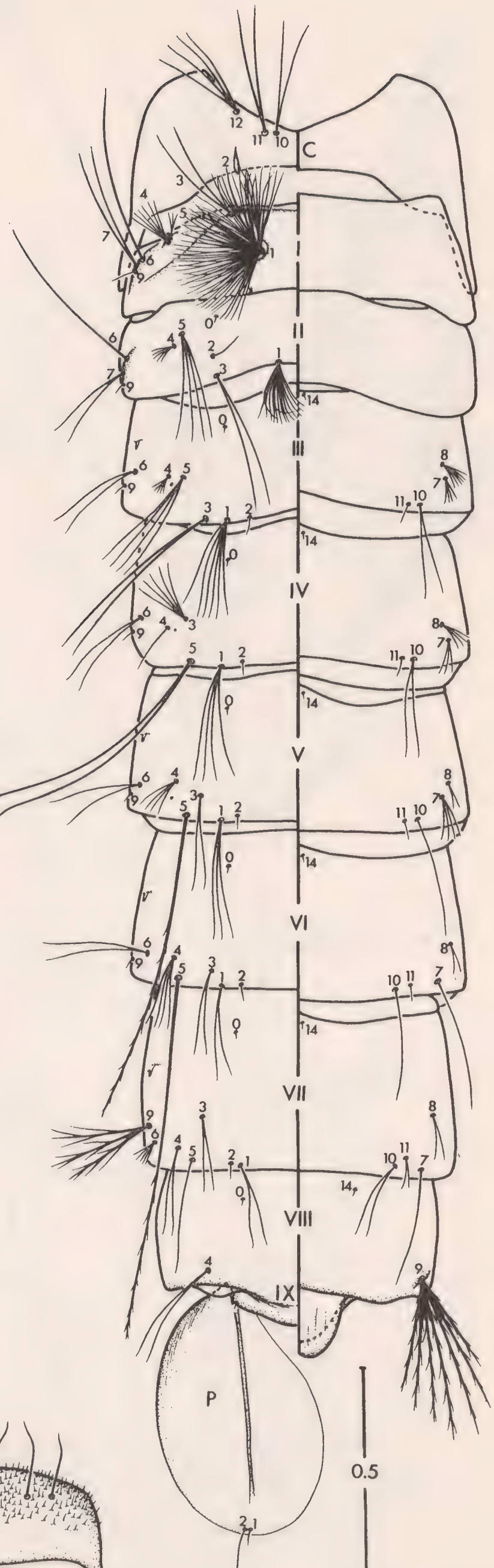


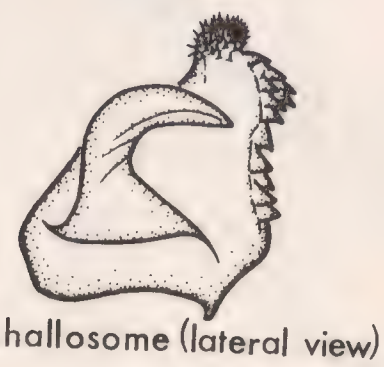
eukrines

C. Chang

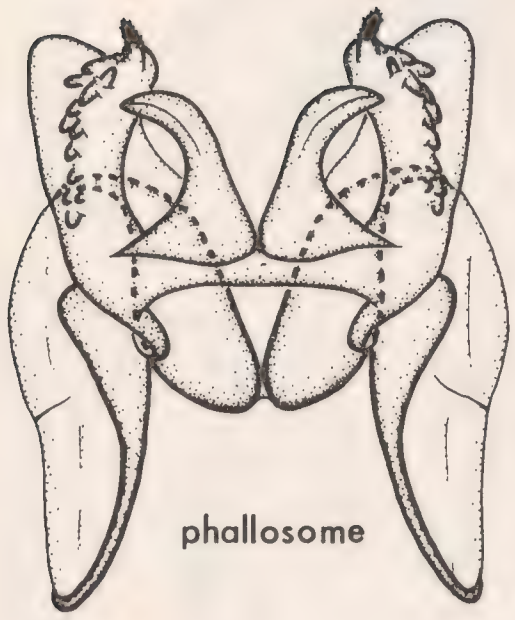
Fig. 53







phallosome (lateral view)

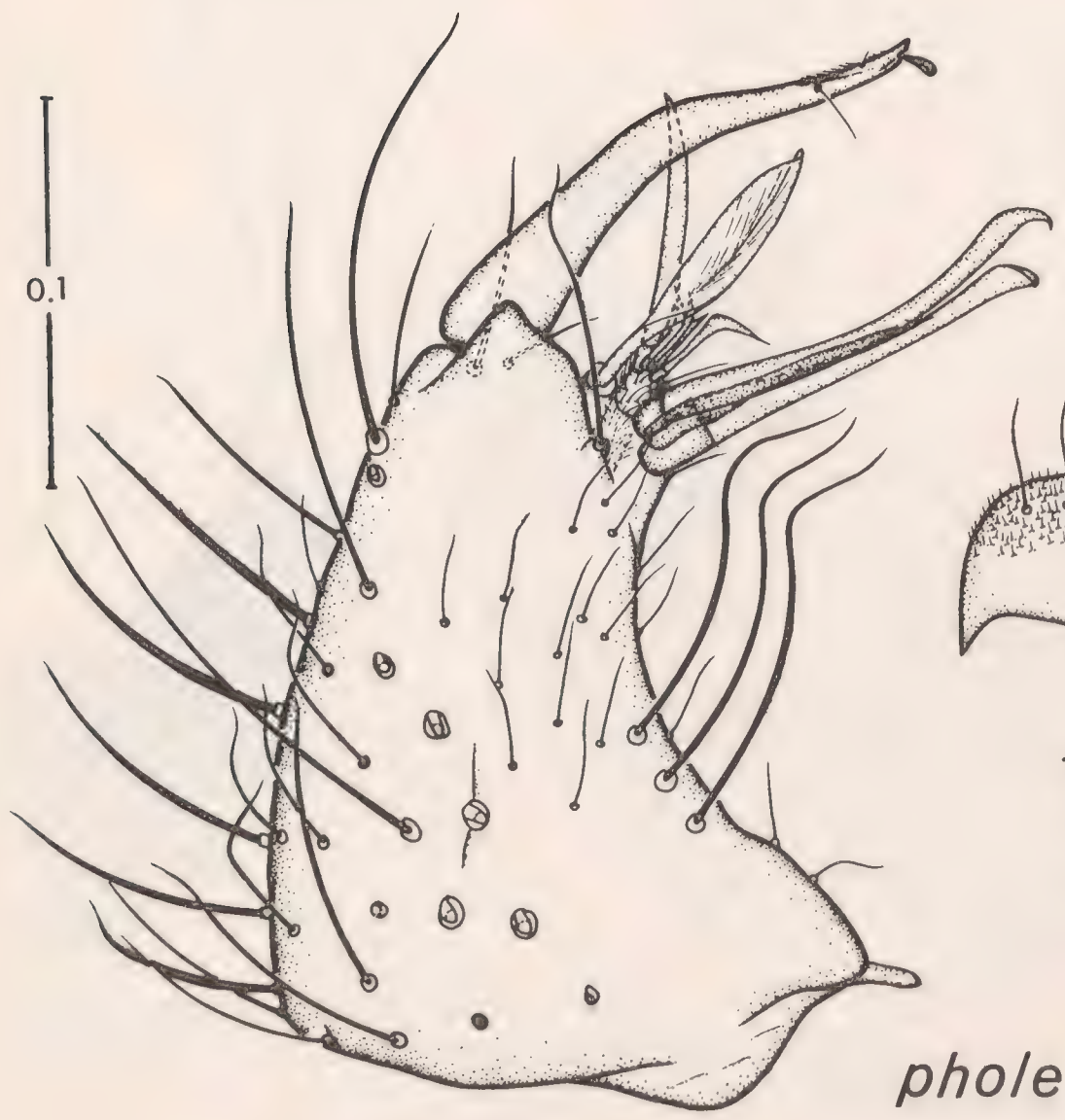


phallosome

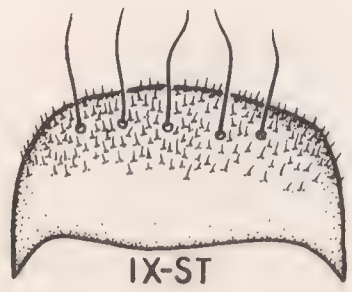
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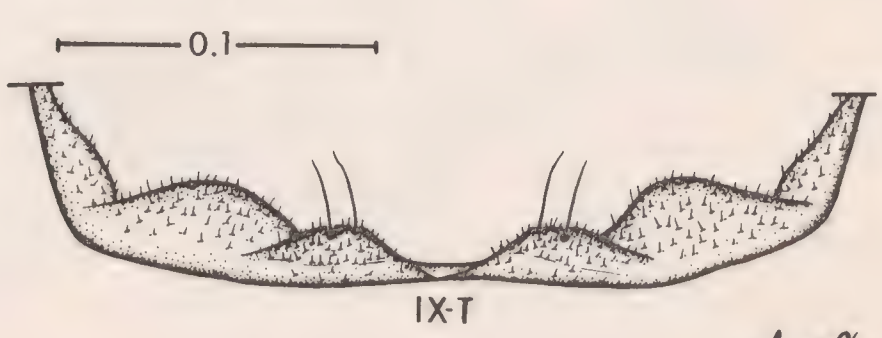


proctiger



0.1

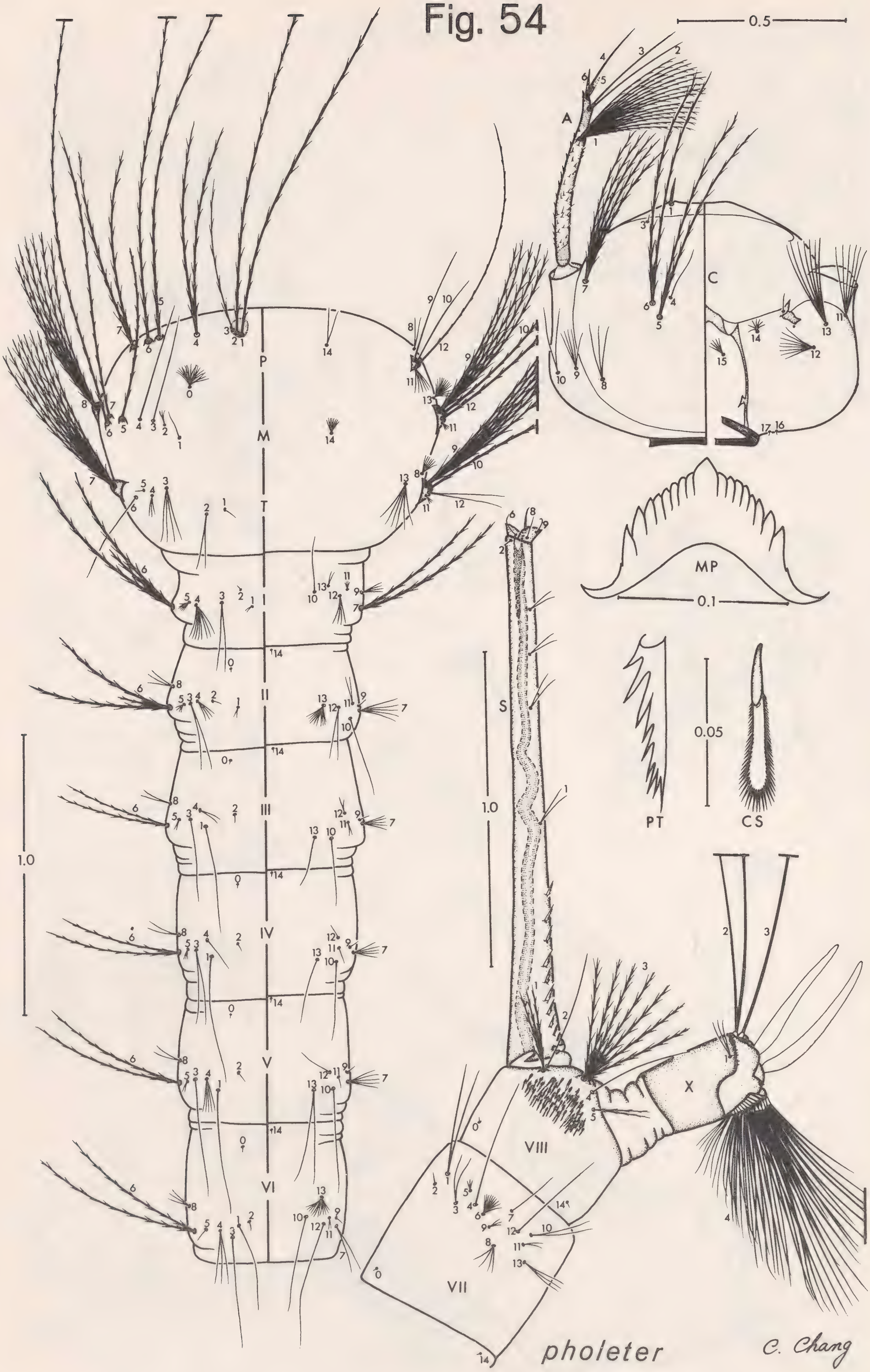




pholeter

C. Chang

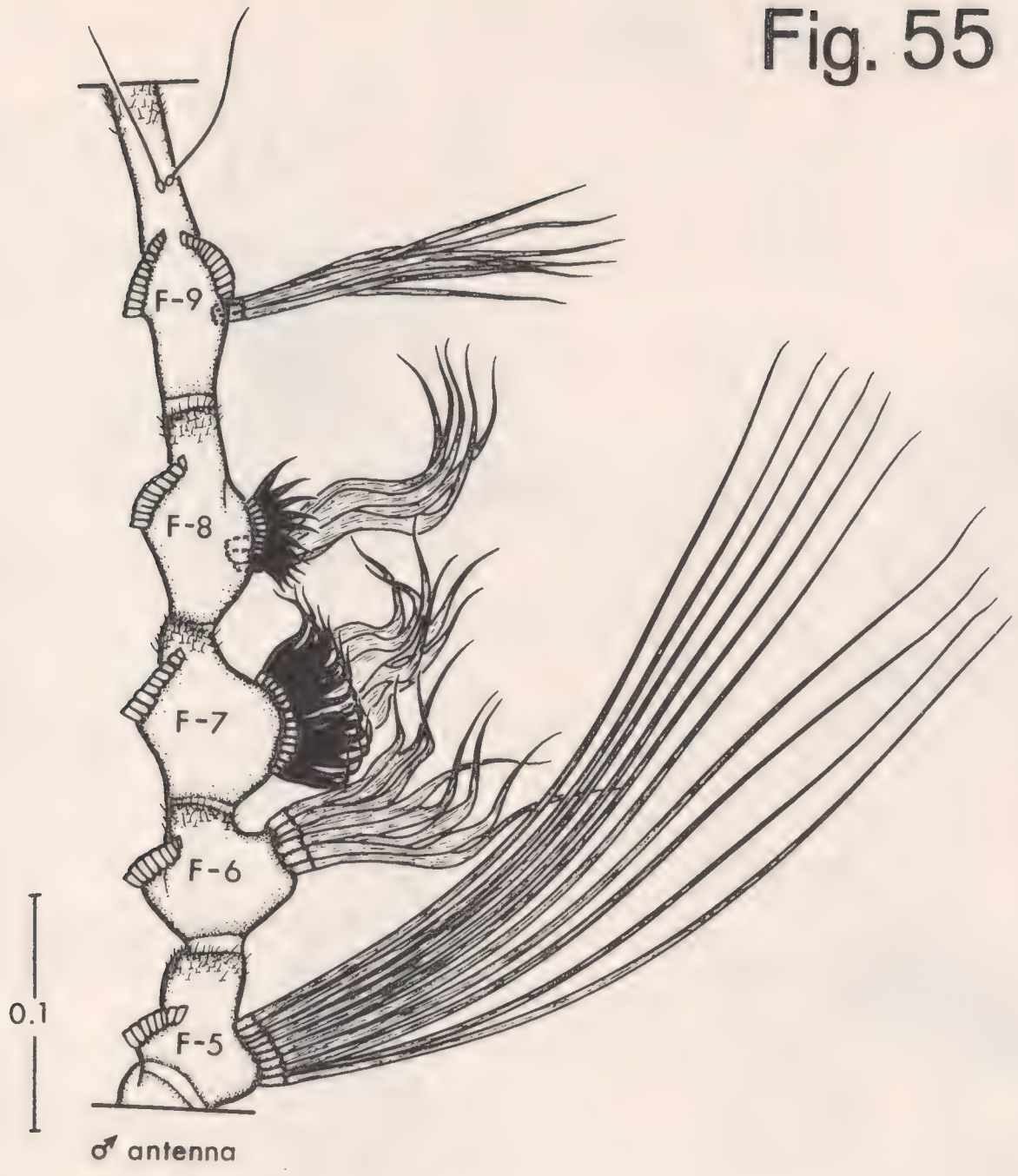
Fig. 54



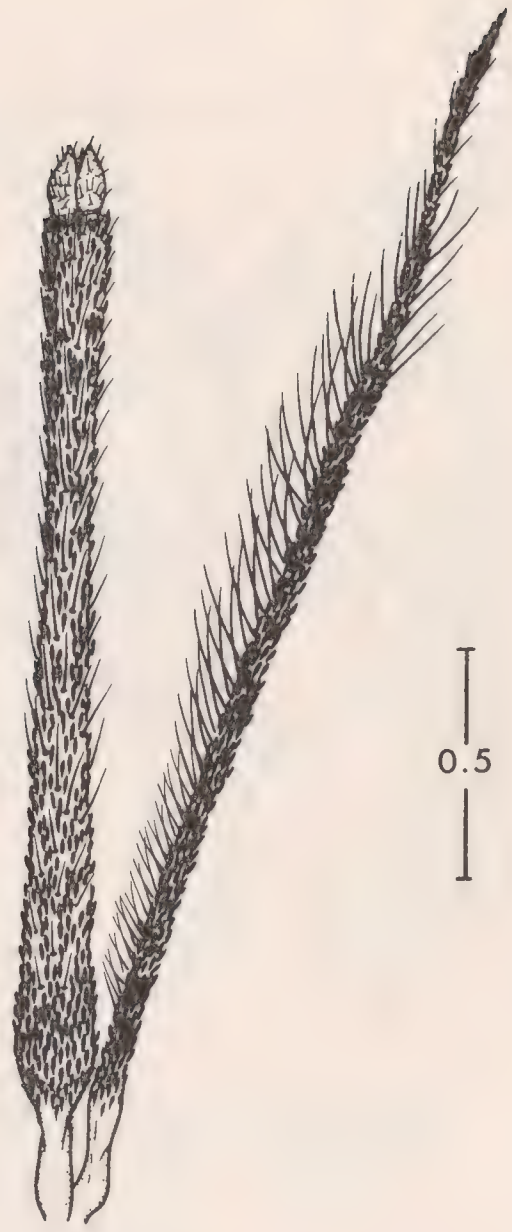
pholeter

C. Chang

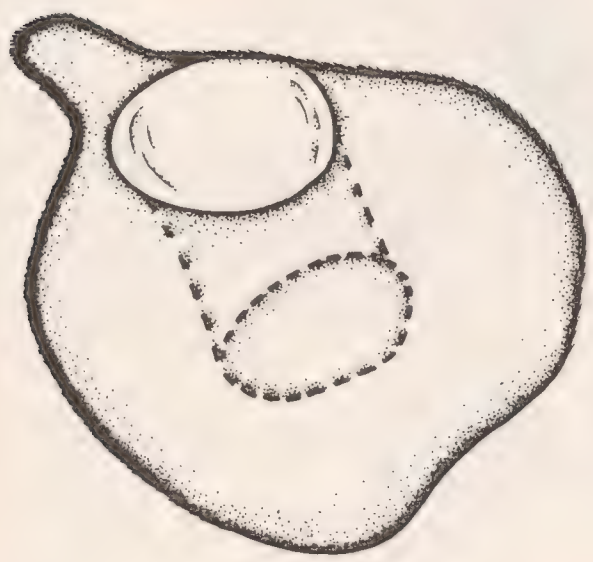
Fig. 55



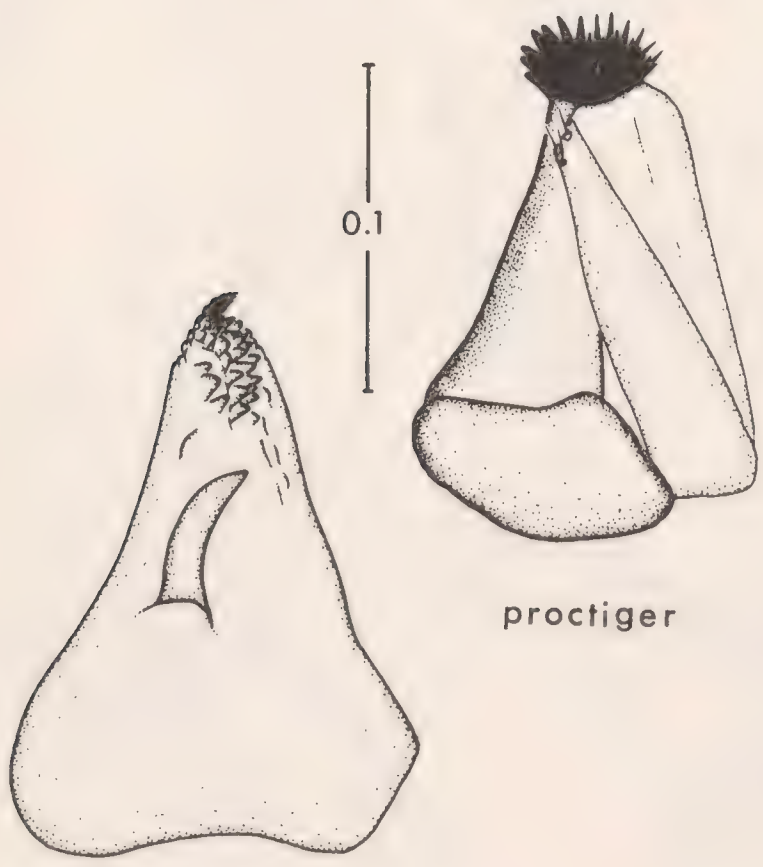
♂ antenna



palpus & proboscis



antennal pedicel



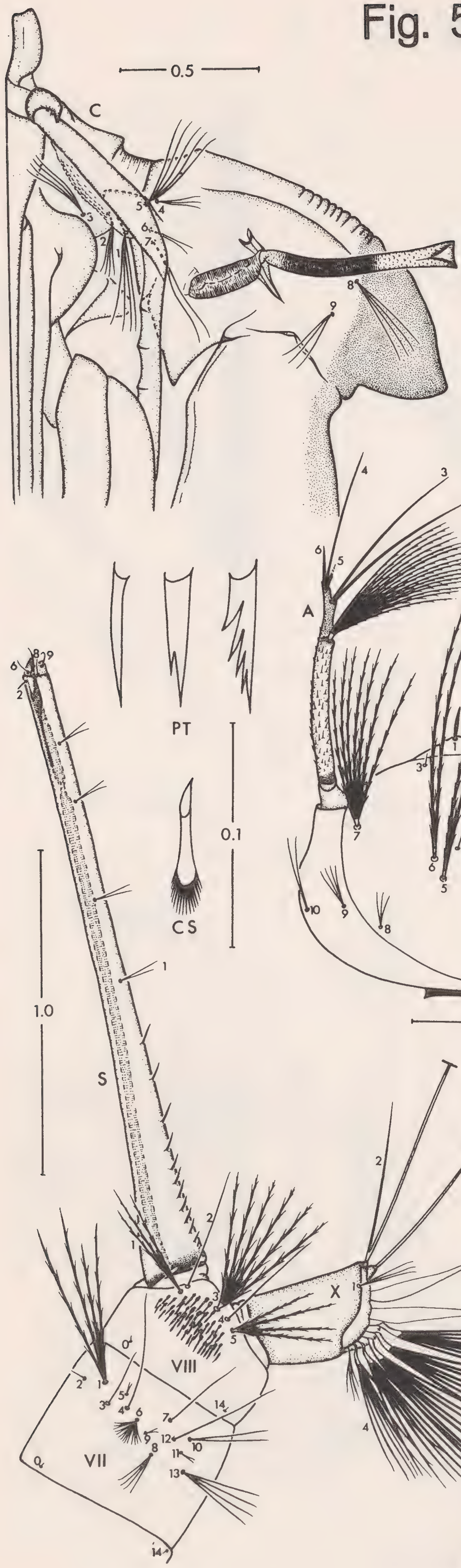
proctiger

phallosome (lateral view)



flavicornis

Fig. 56


0.5
C
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0.5
C
X
VIII
VII
flavicornis

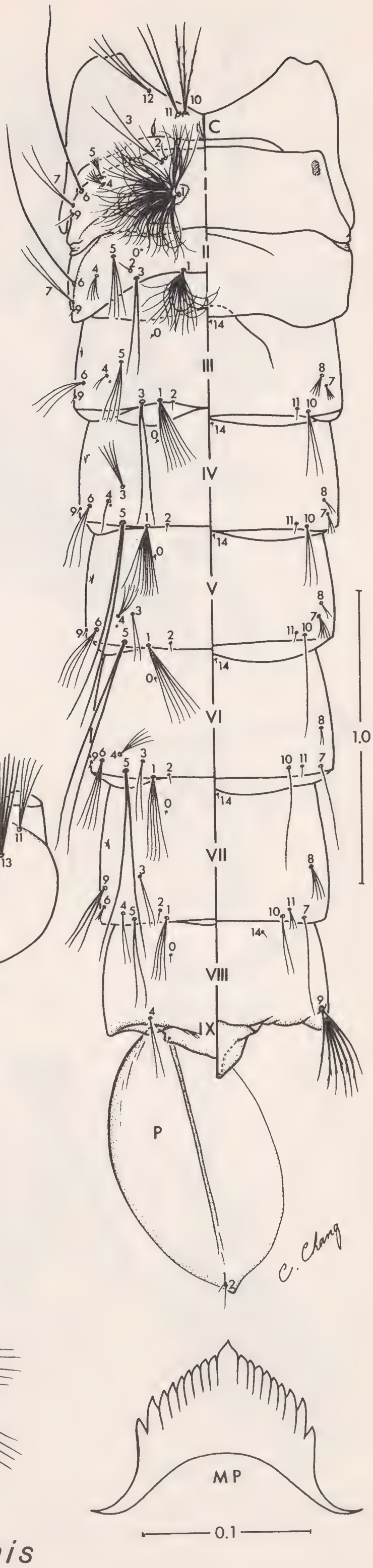
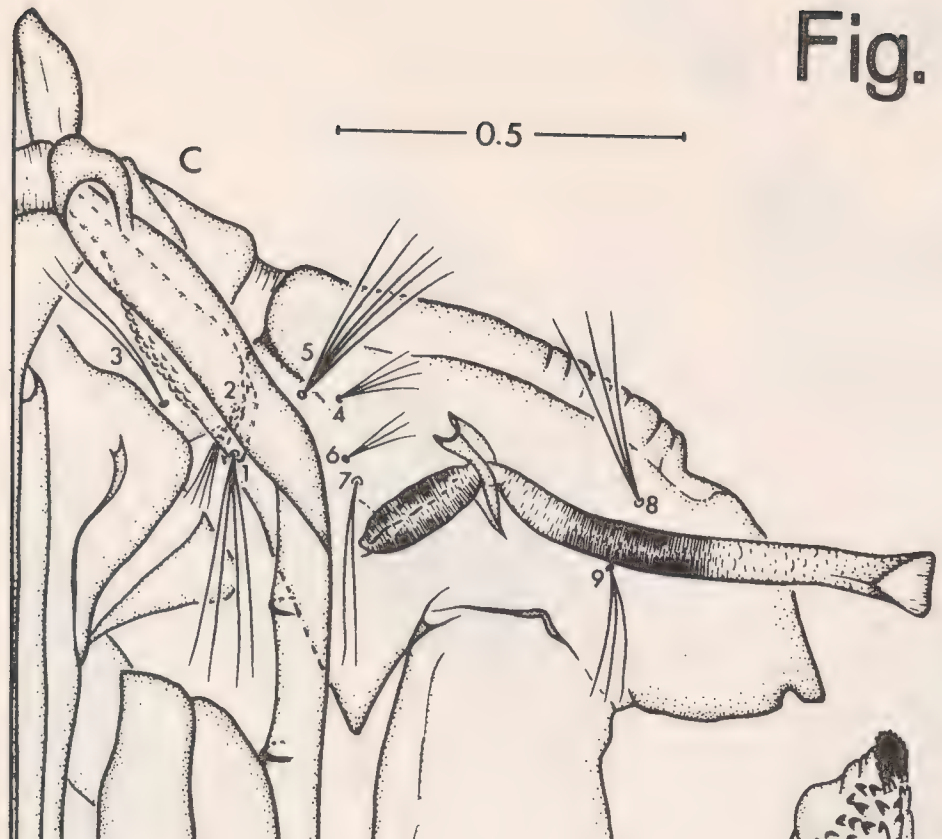
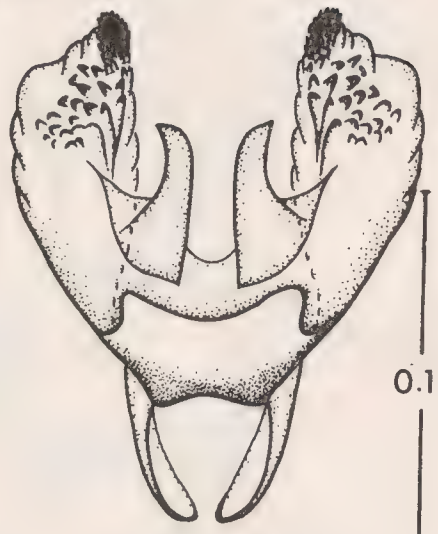
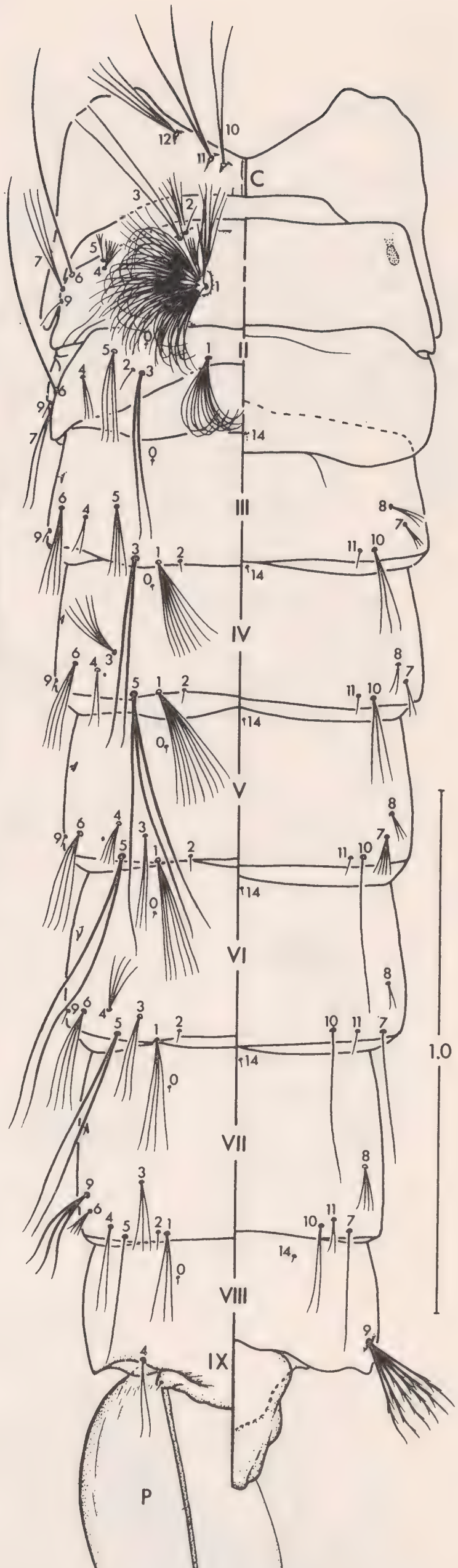
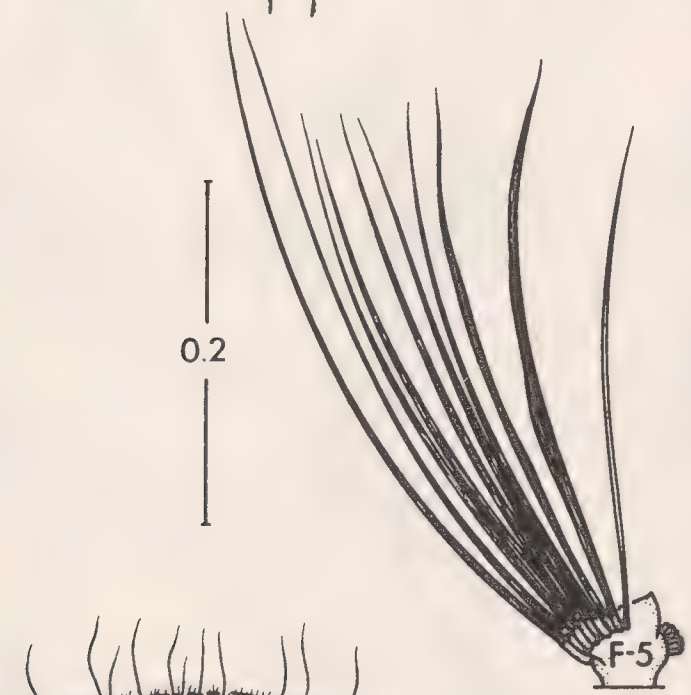

C
IV
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VII
VIII
IX
P
1.0
MP
0.1
C. Chang

Fig. 57

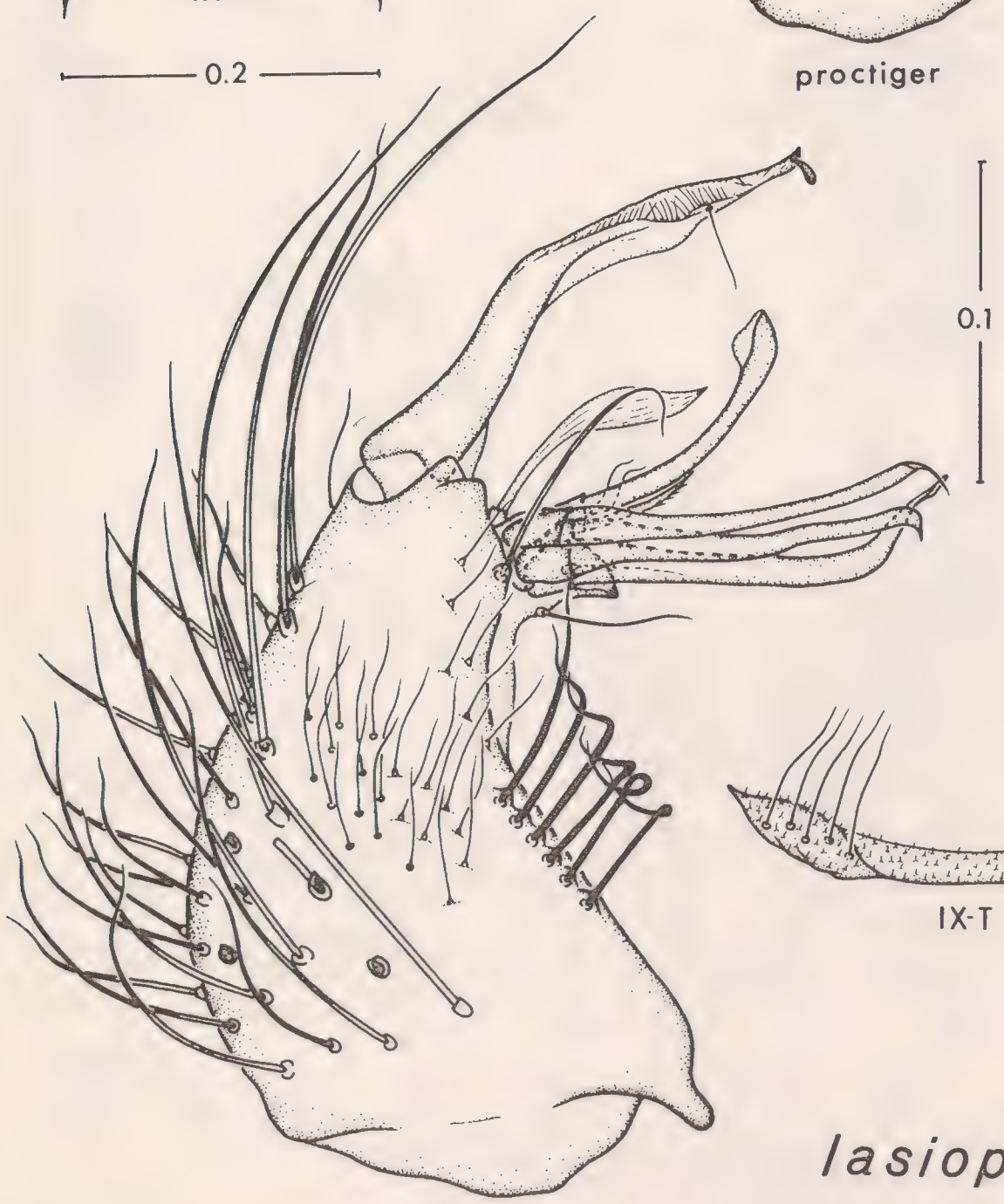






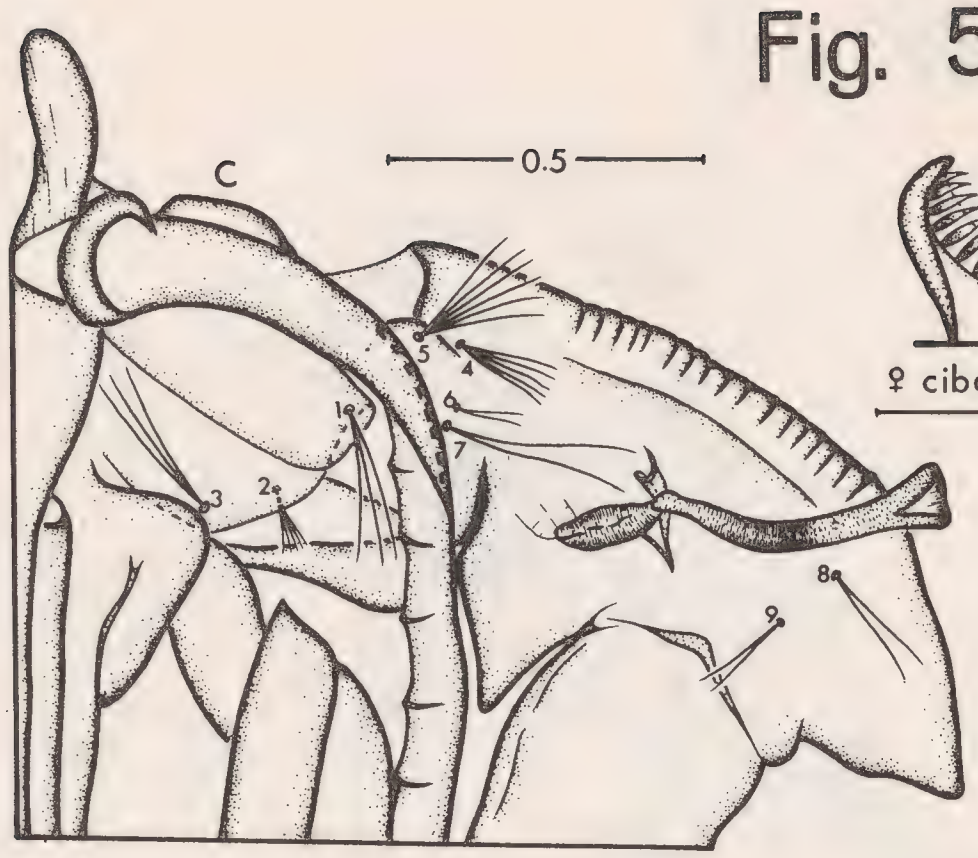


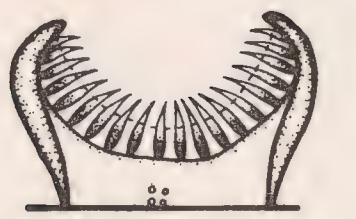


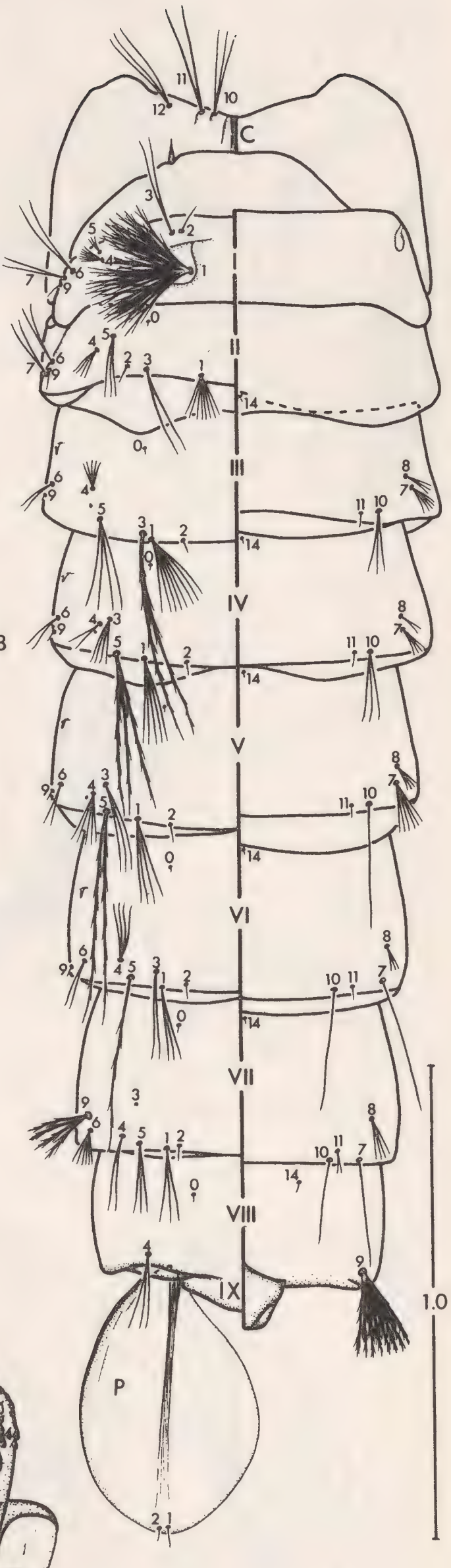


lasiopalpis

Fig. 58



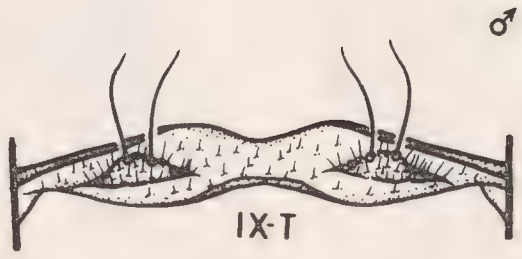


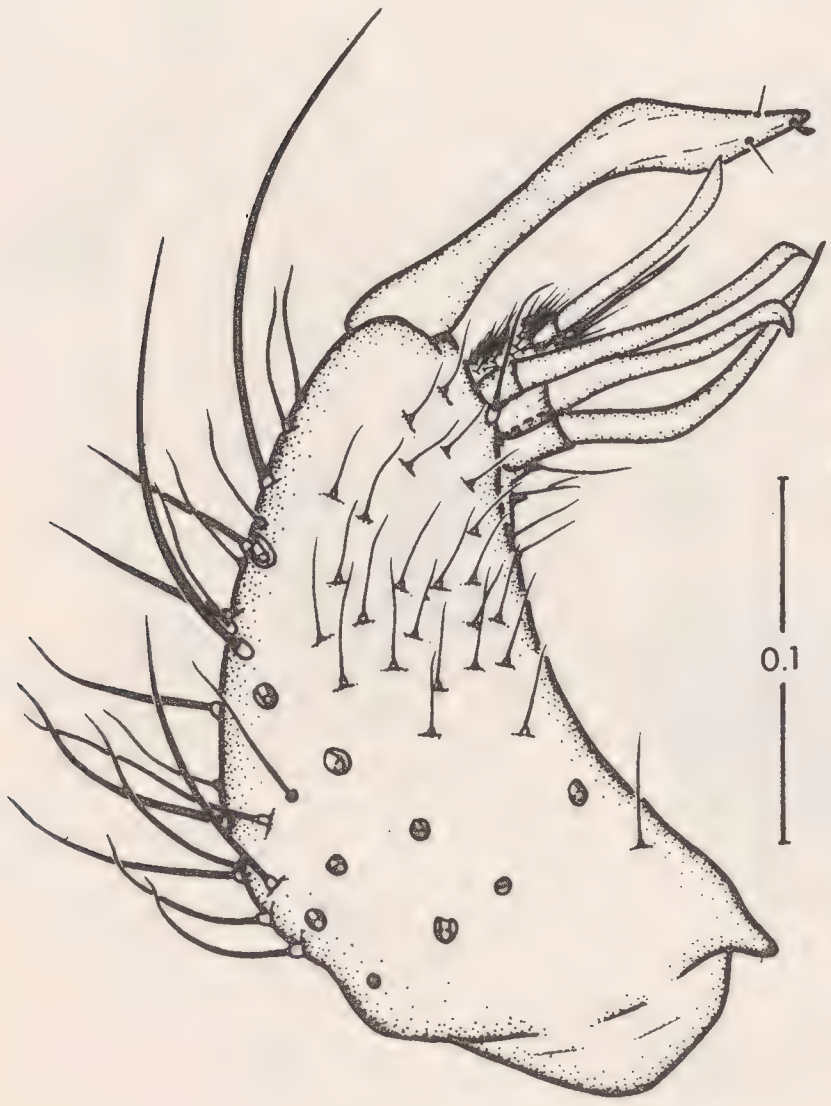




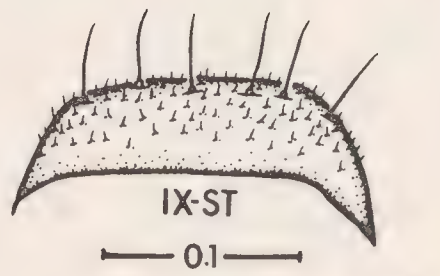








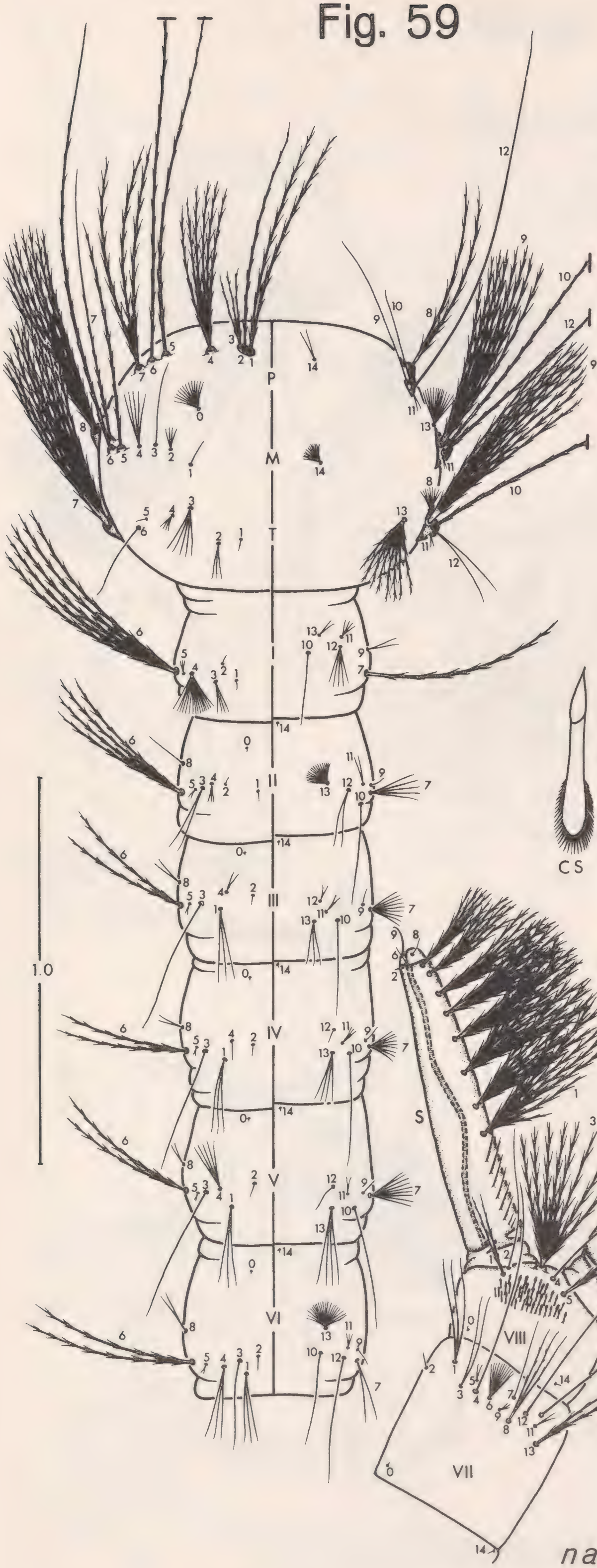


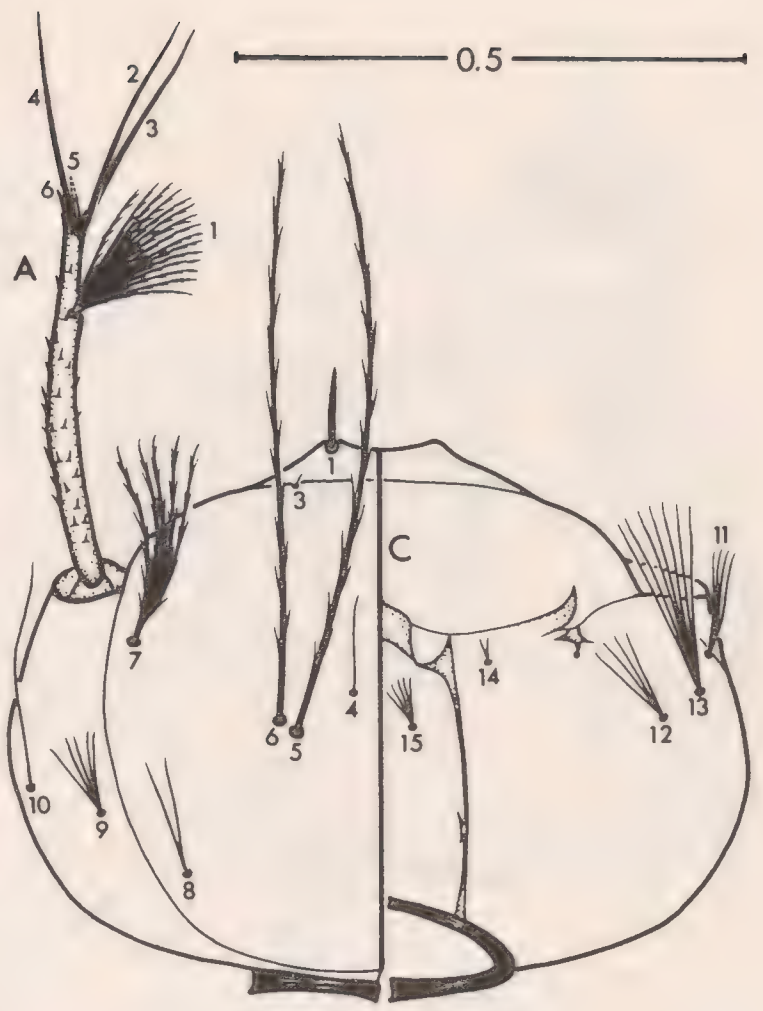


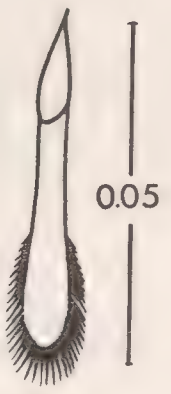
C. Chang

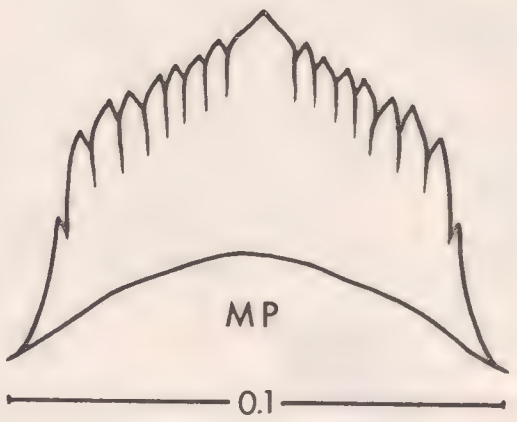
navalis

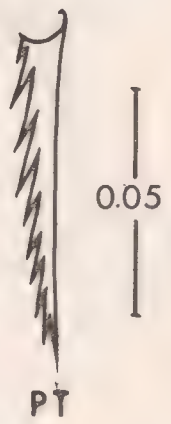
Fig. 59

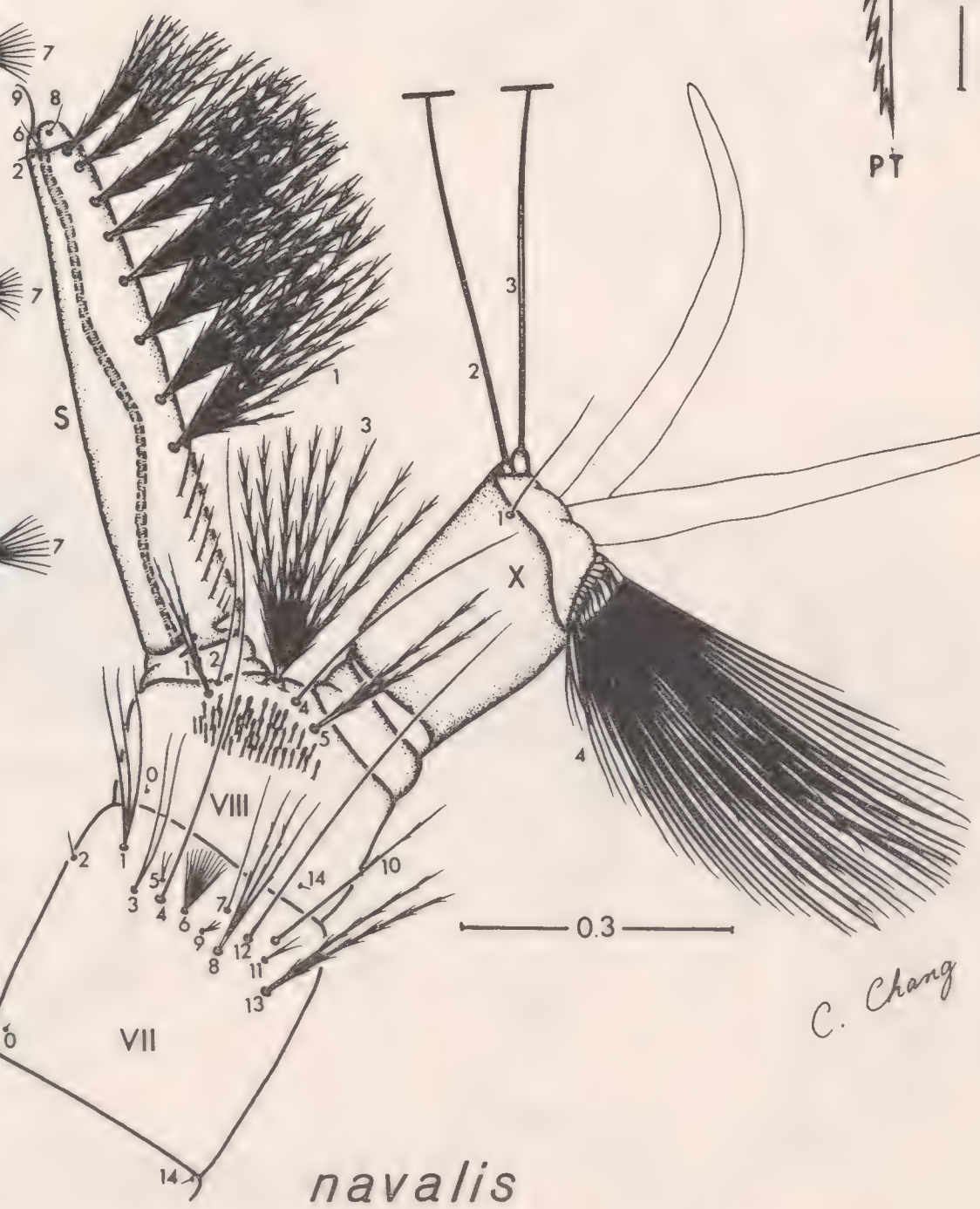








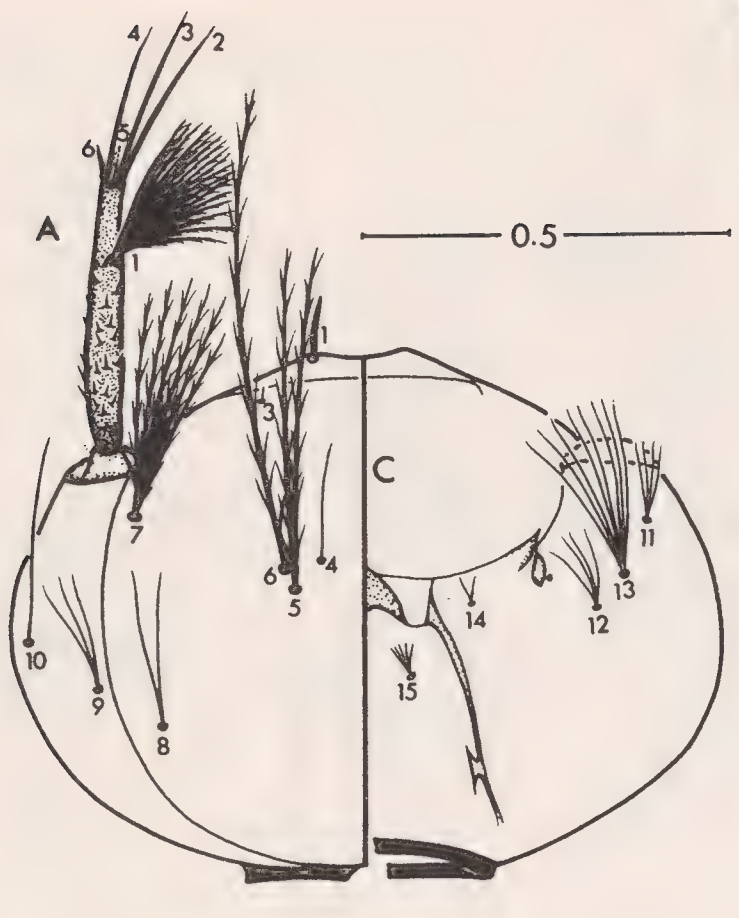


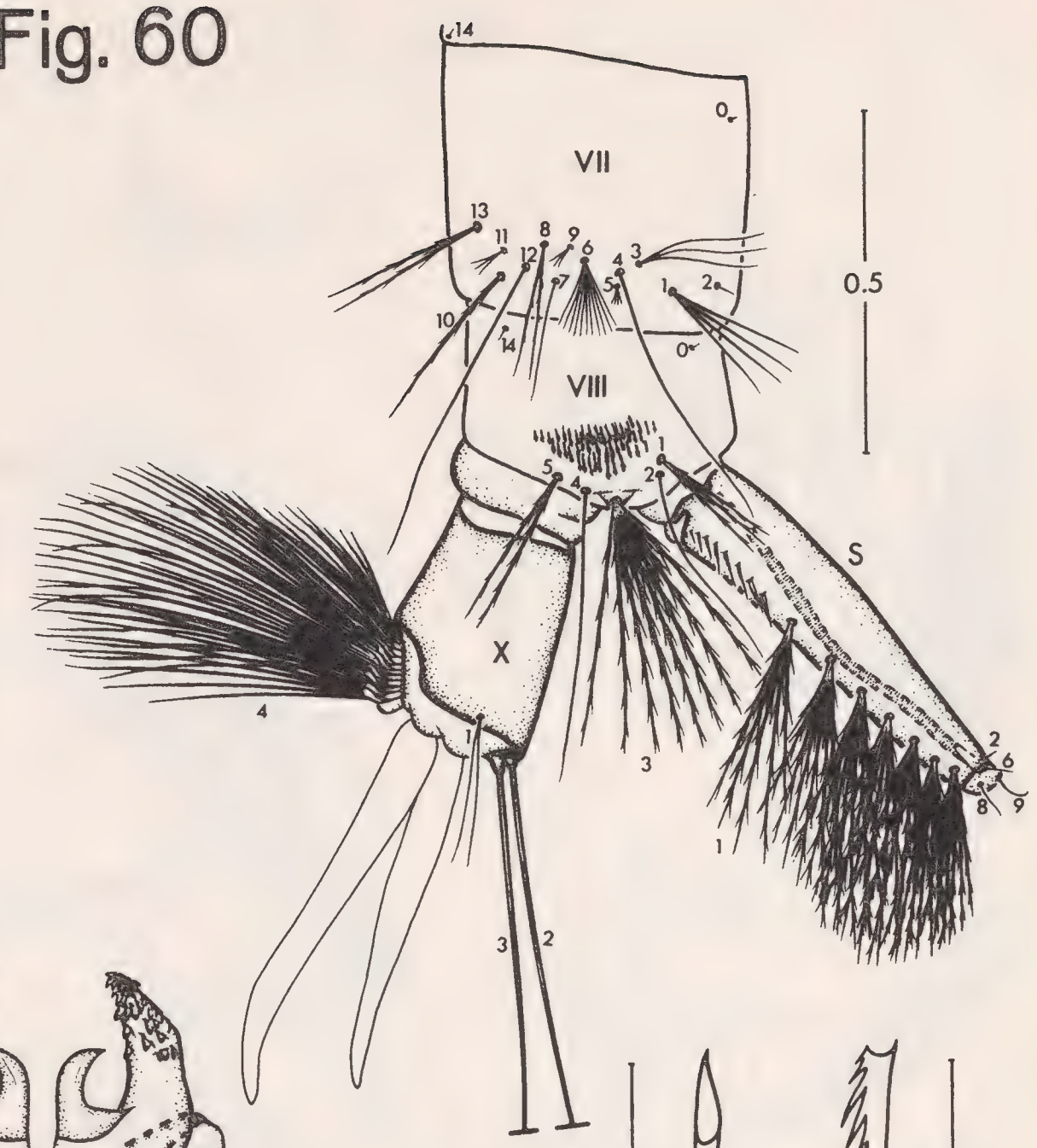


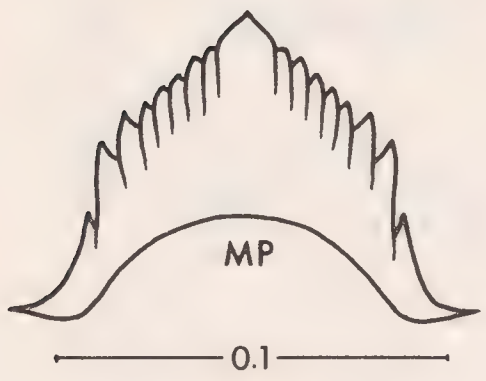
C. Chang

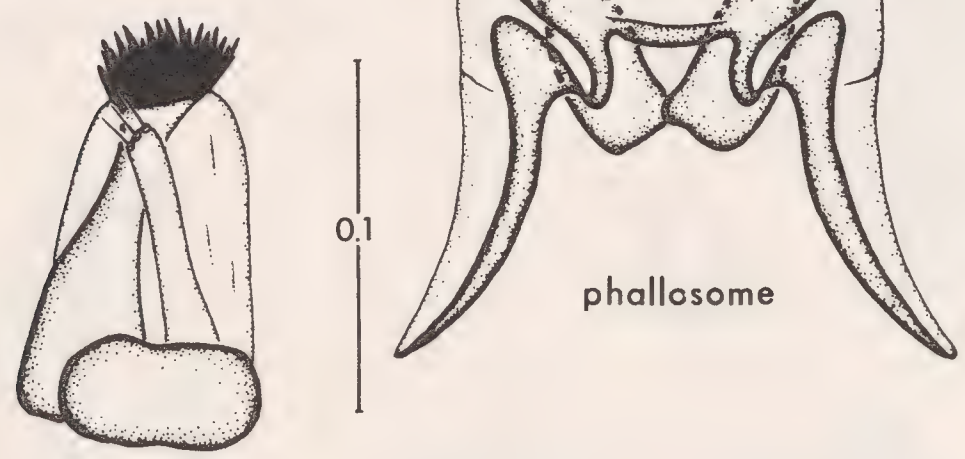
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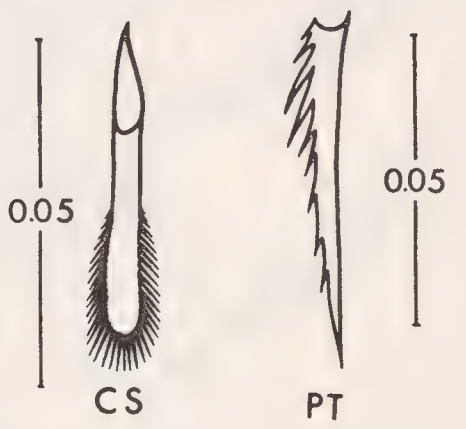
Fig. 60

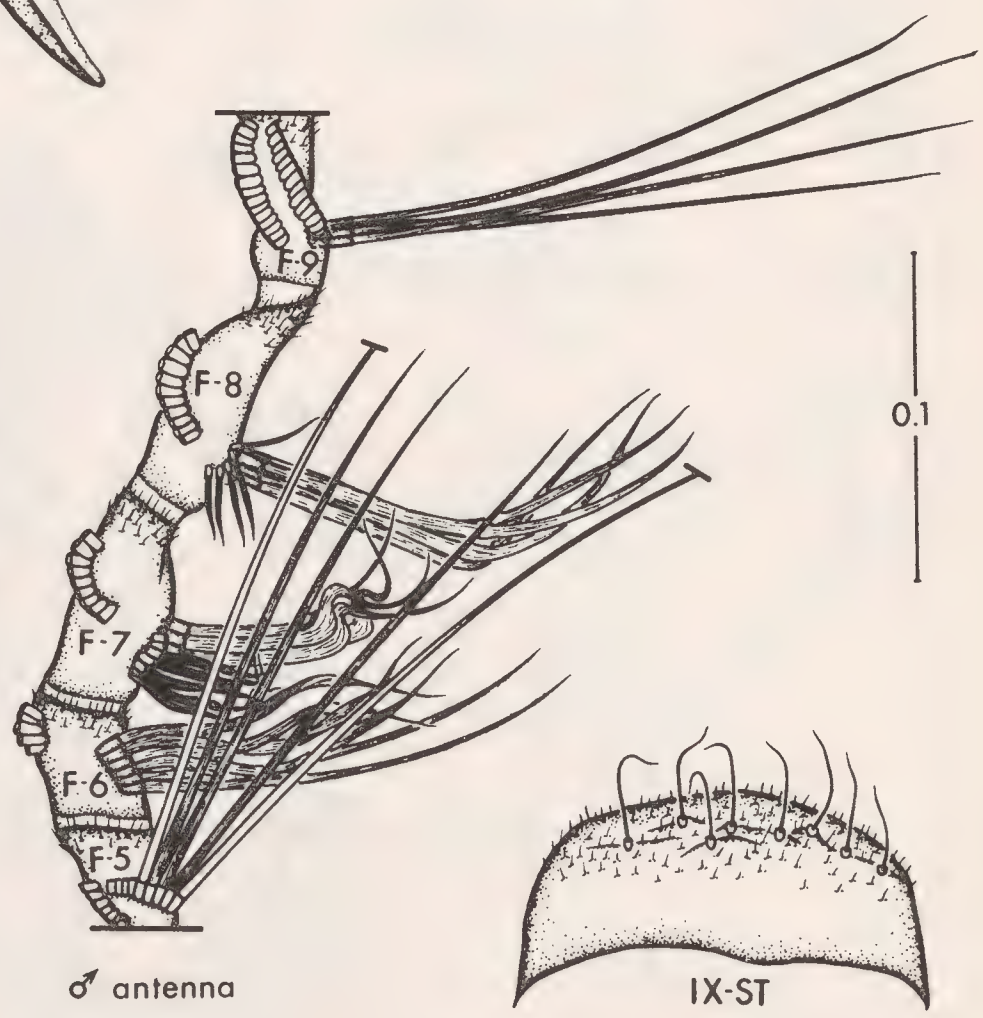


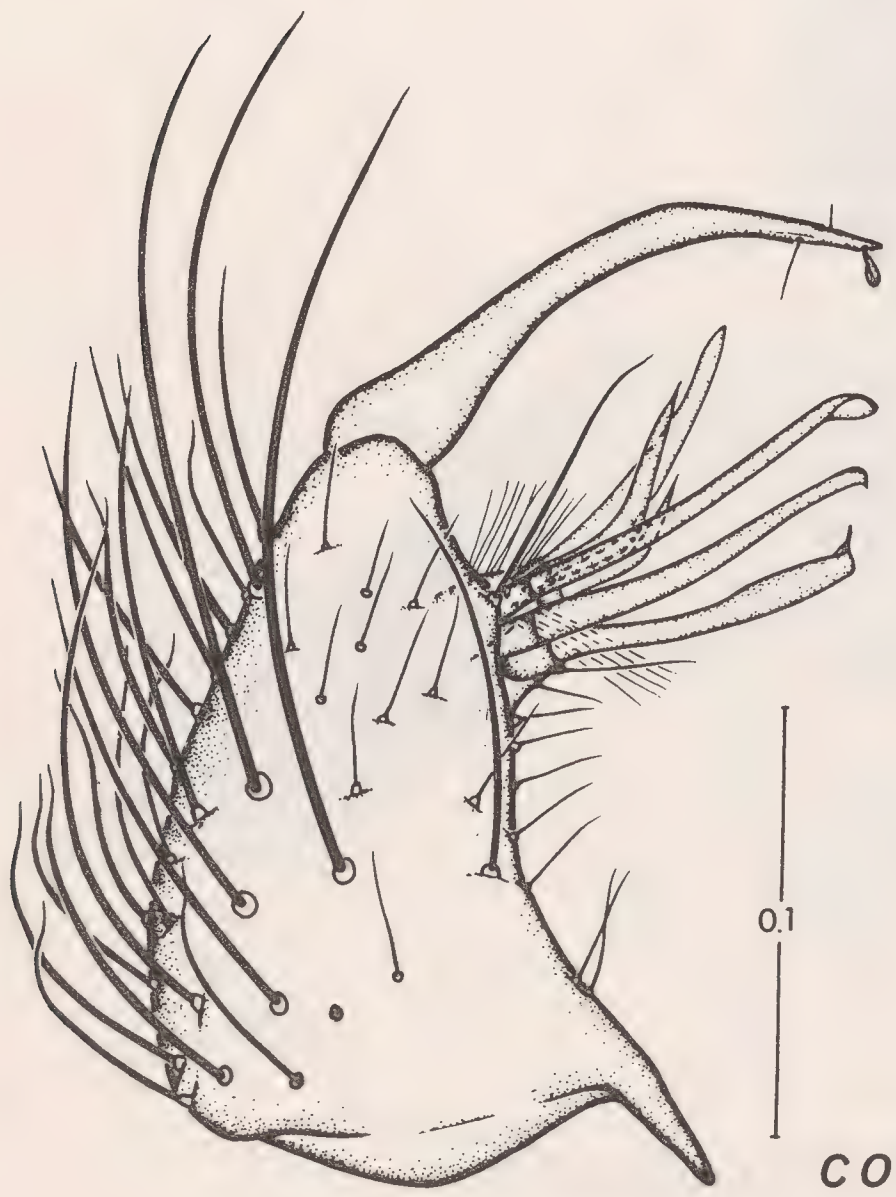


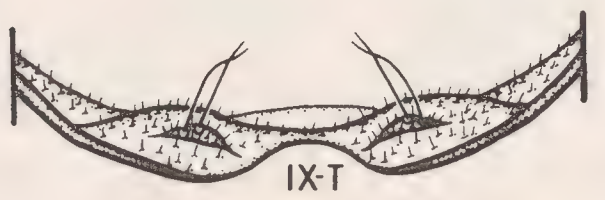








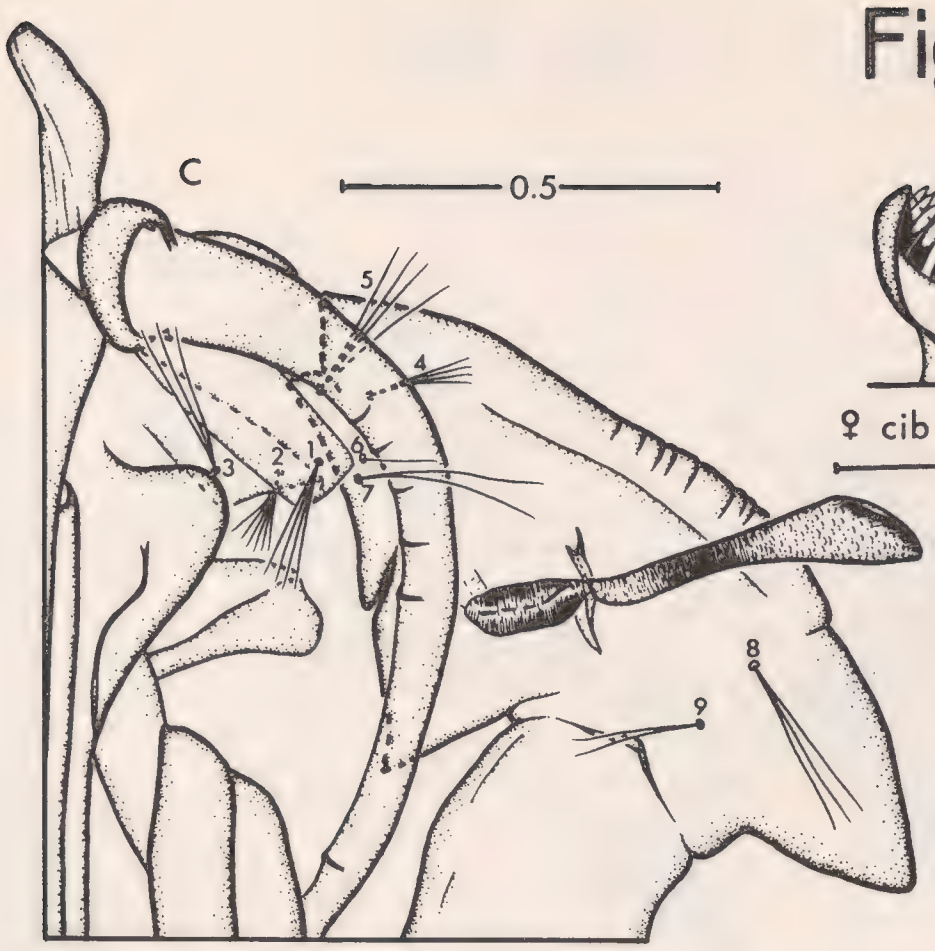




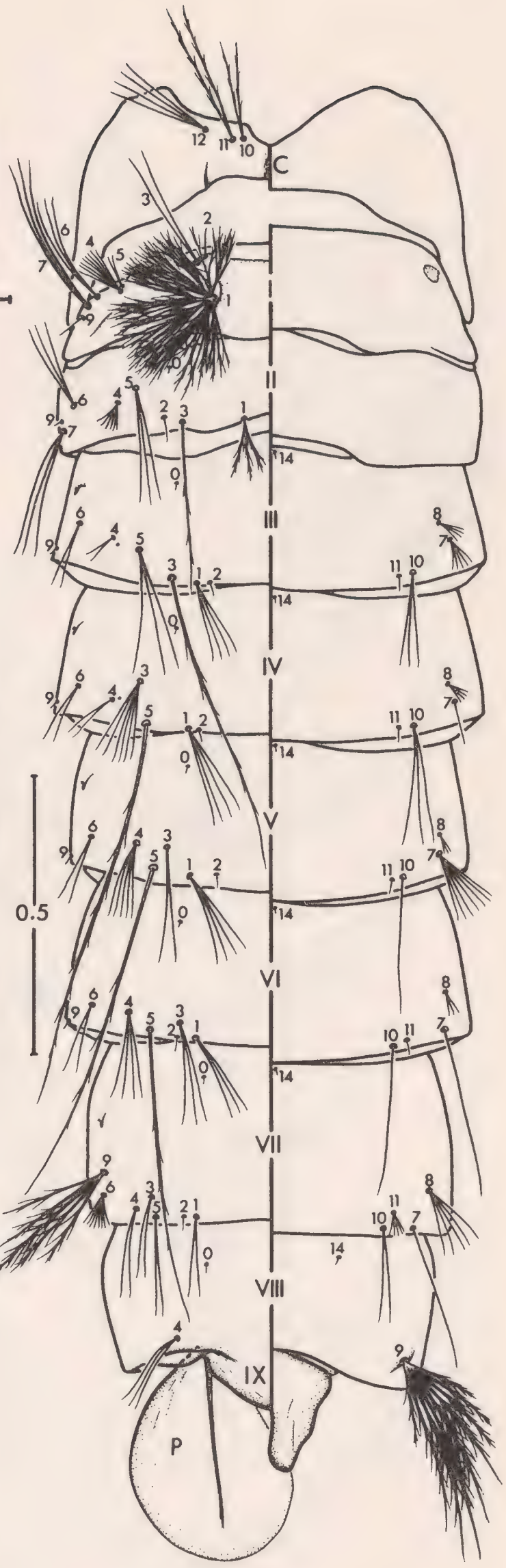
C. Chang

coerulescens

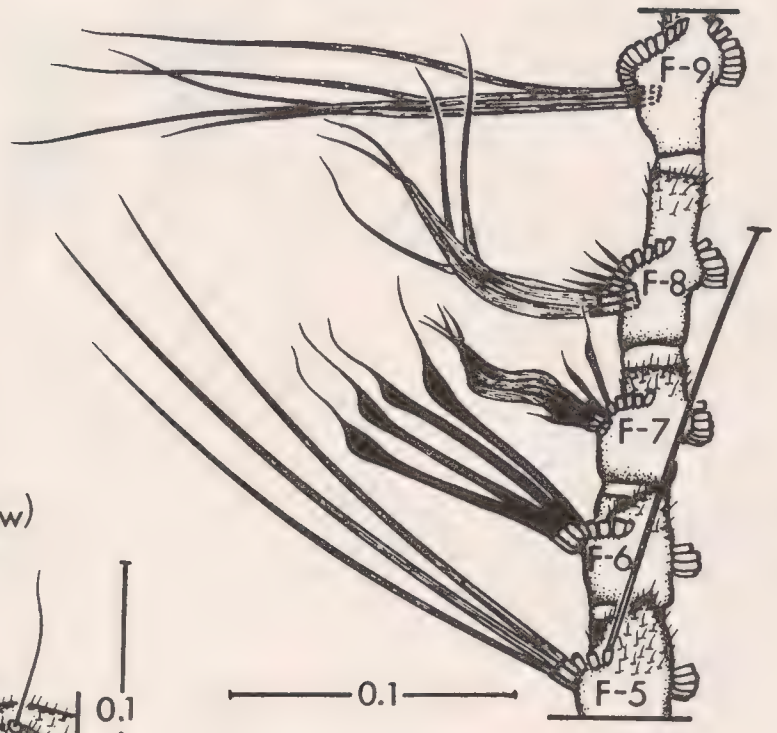
Fig. 61

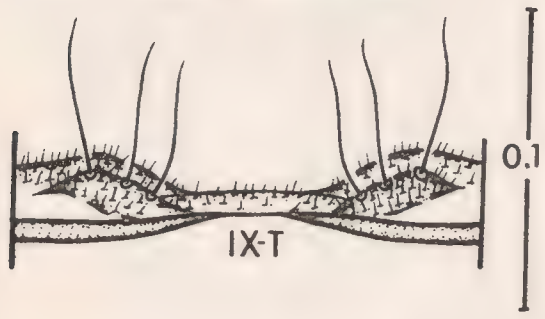


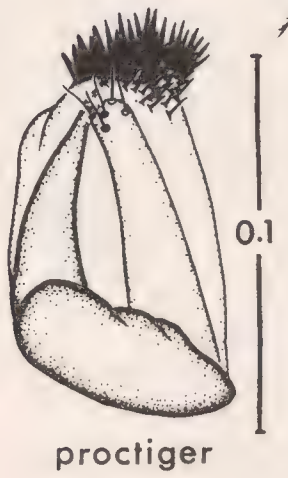


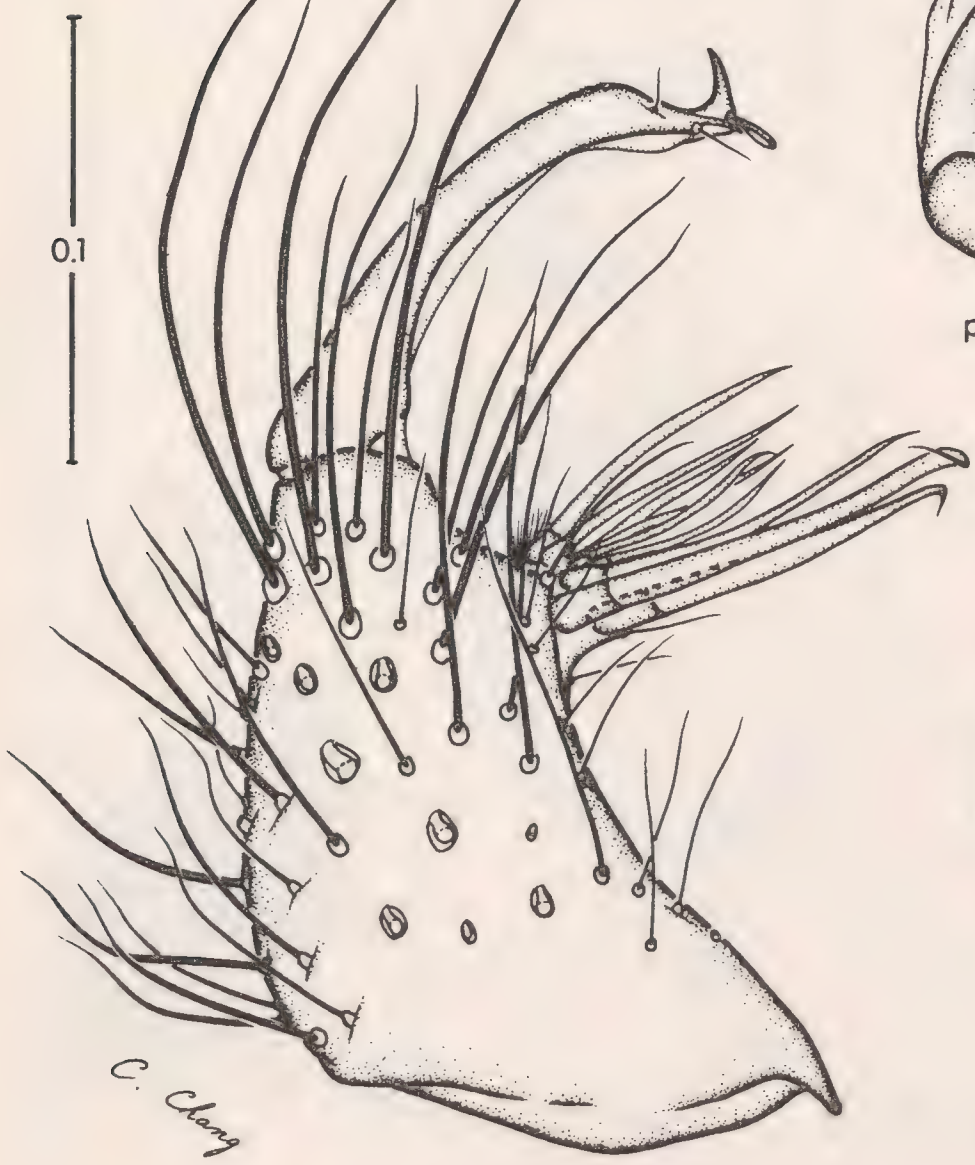


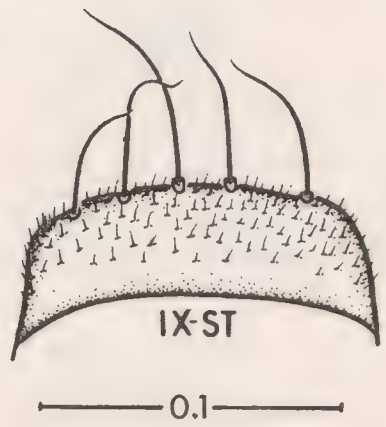


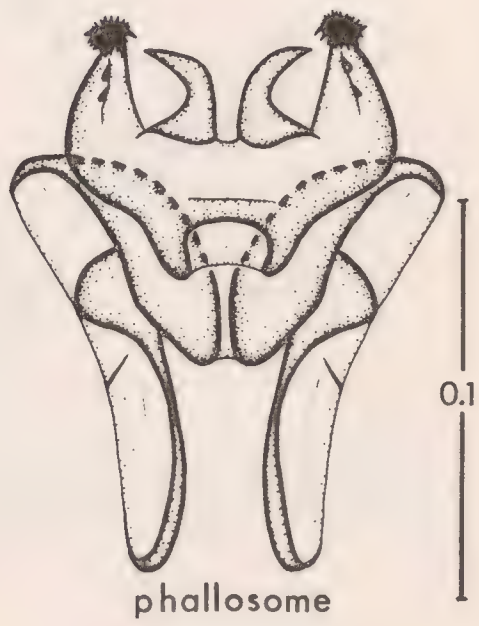






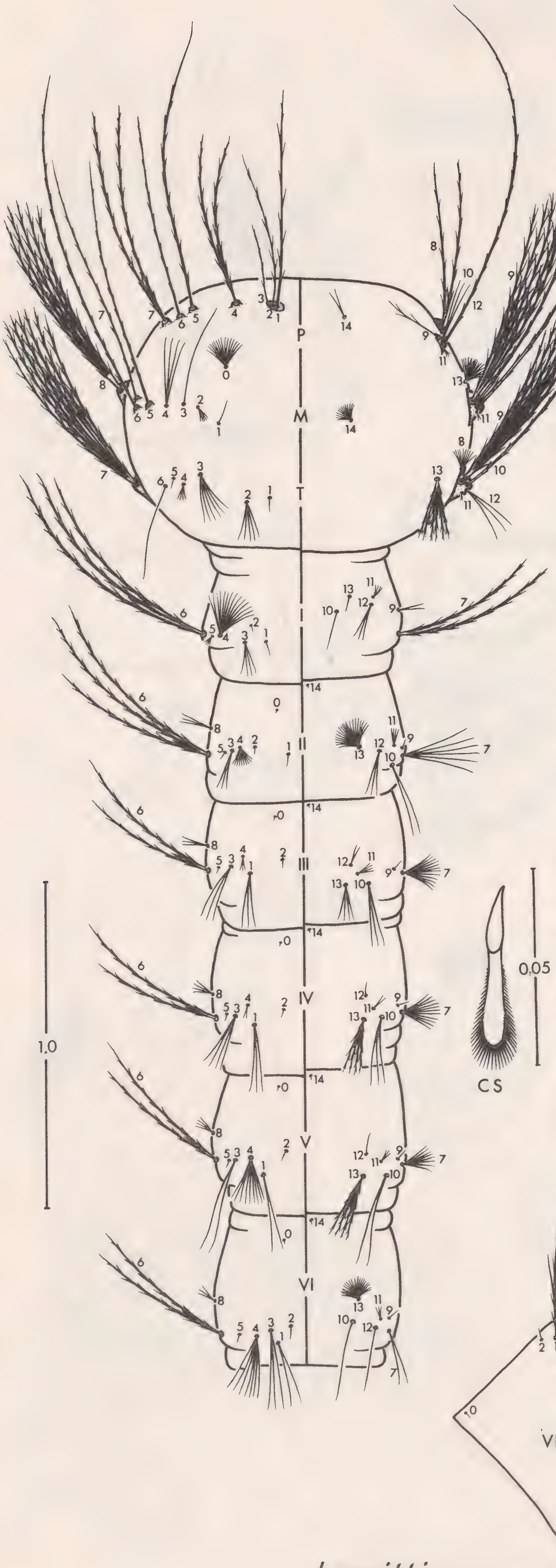


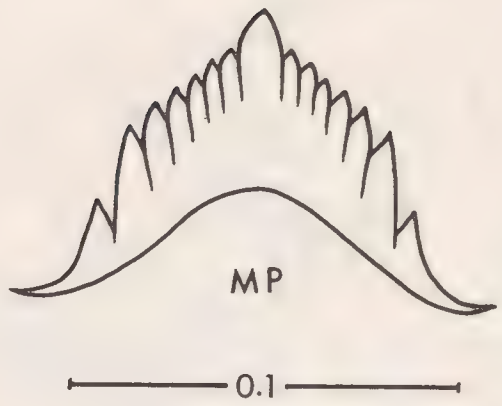


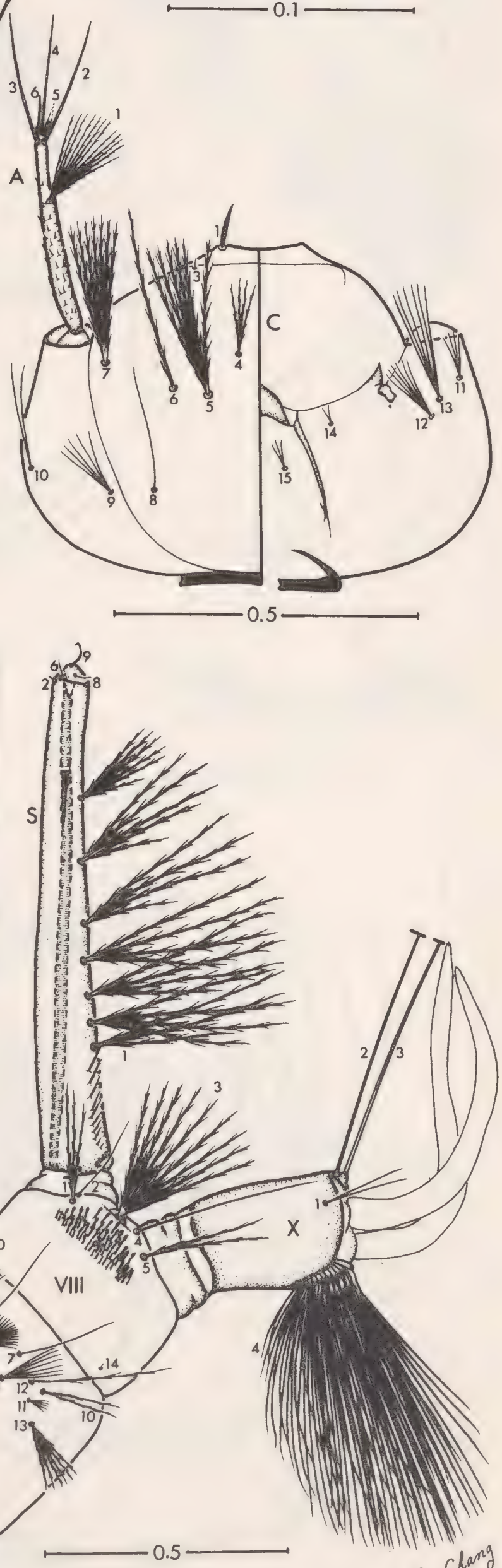


hewitti

Fig. 62



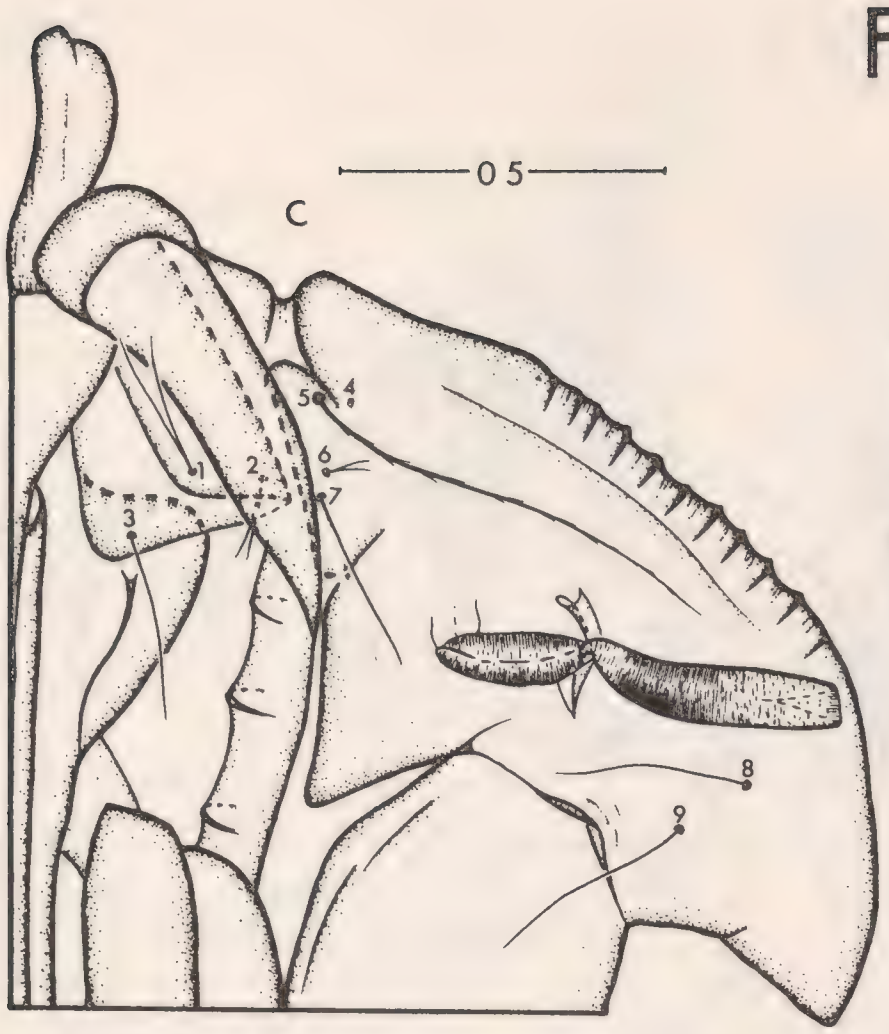


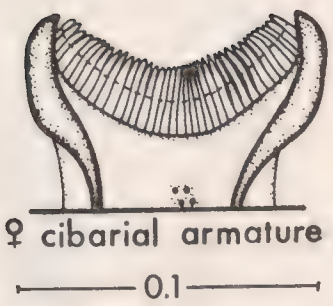


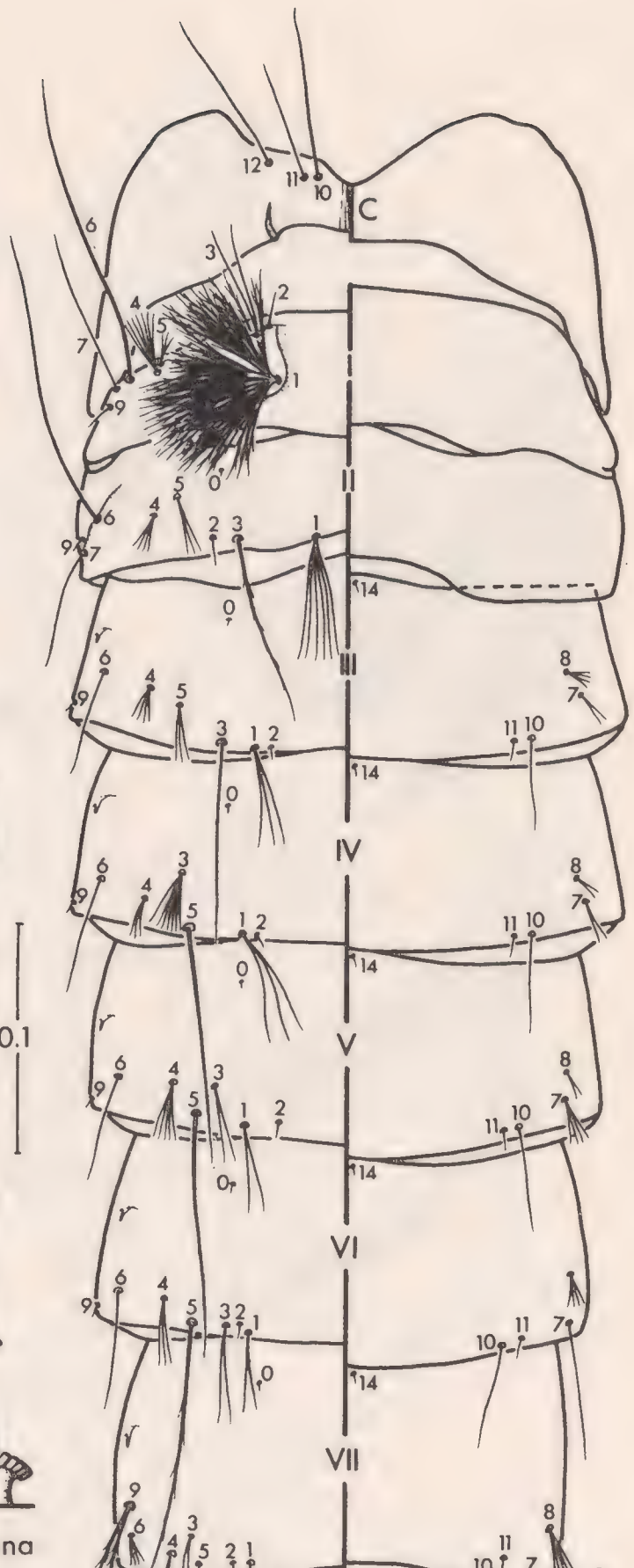
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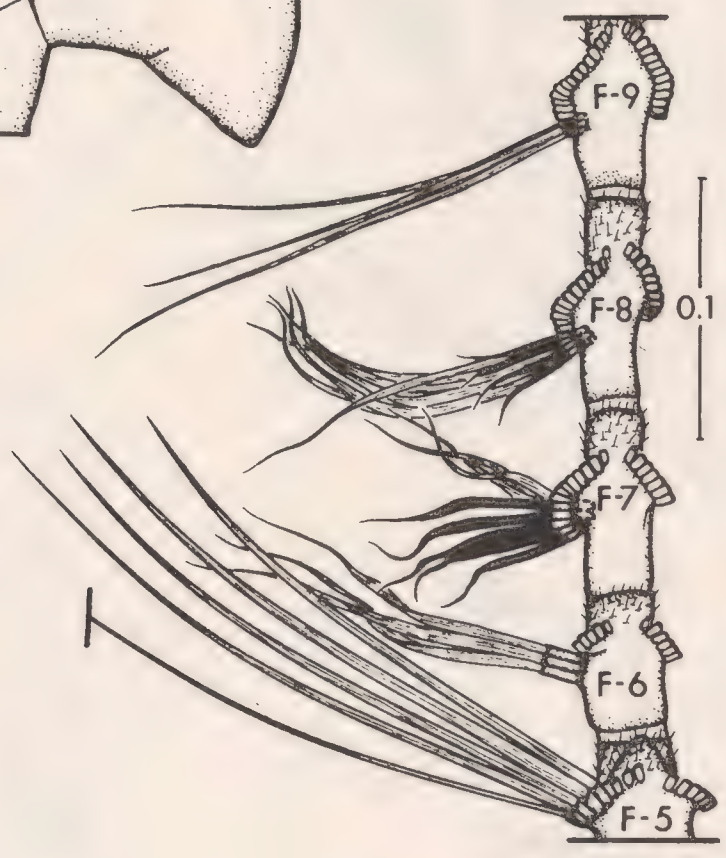
C. Chang

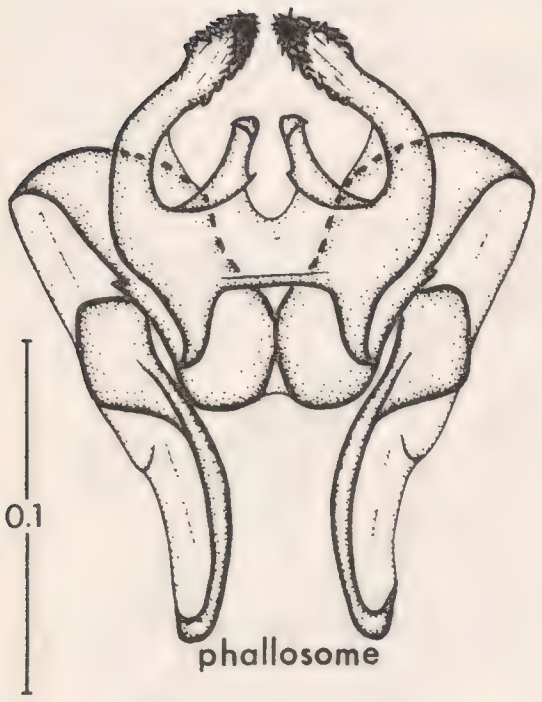
Fig. 63


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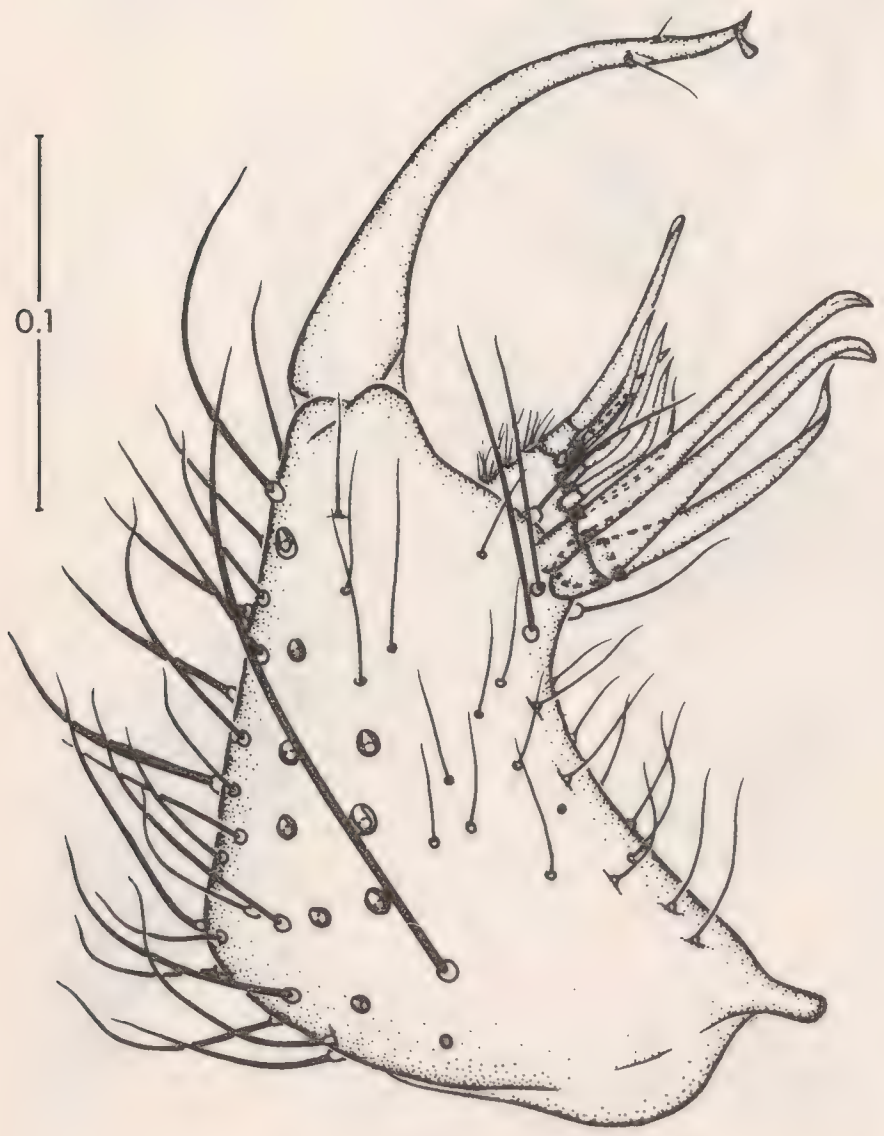

♀ cibarial armature
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C. Chang

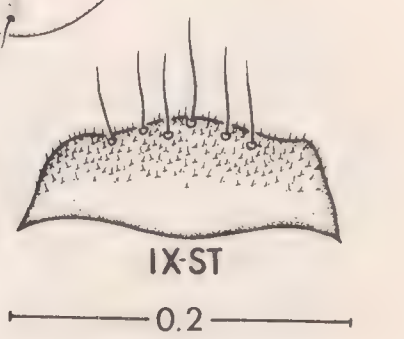

F-9
F-8
F-7
F-6
F-5
0.1
♂ antenna


0.1
phallosome


phallosome (lateral view)
0.1


0.1
jenseni


proctiger


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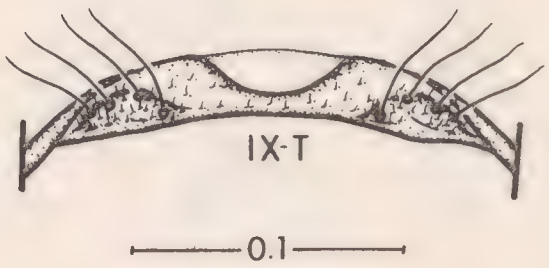

IX-T
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Fig. 64

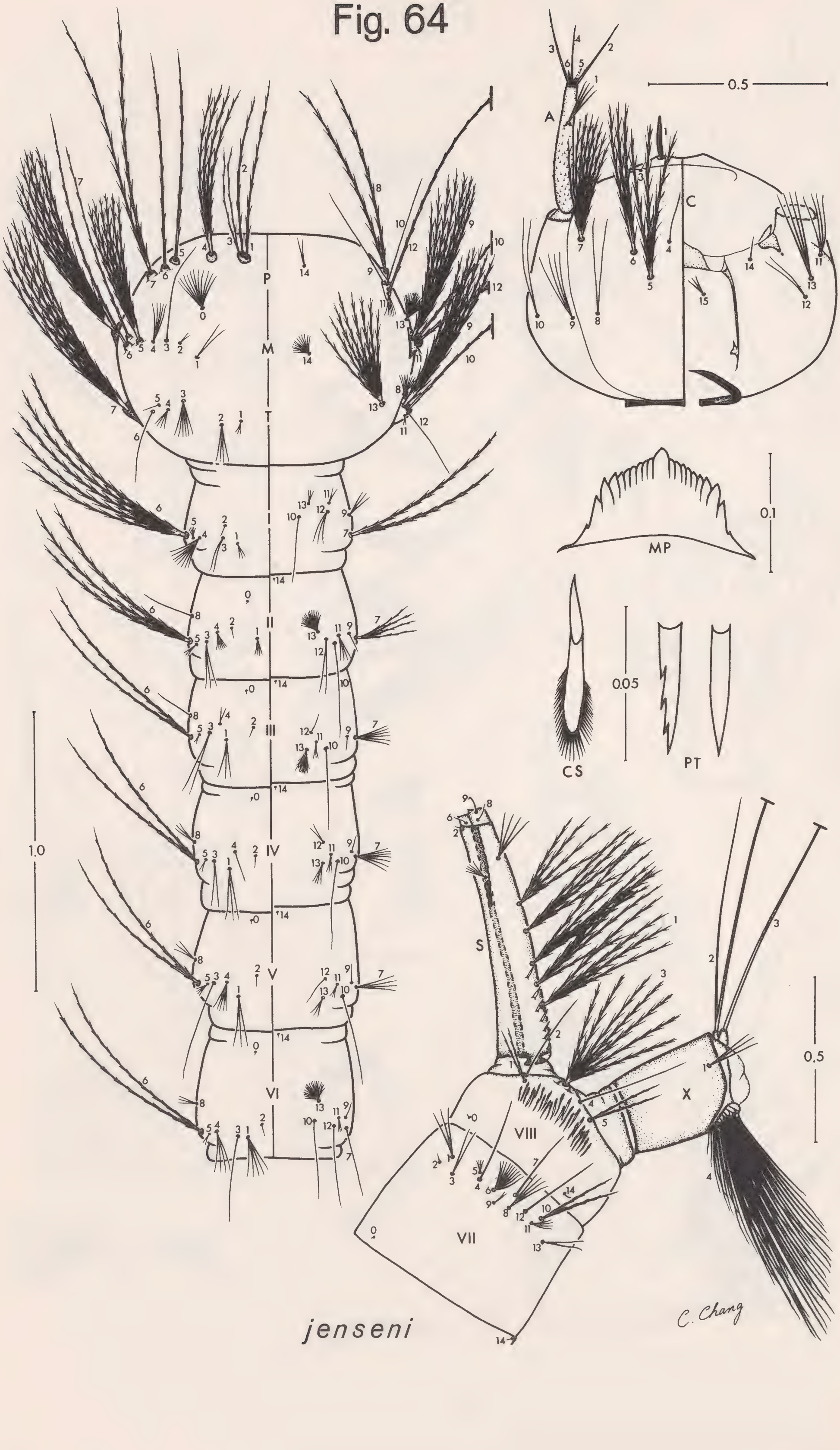
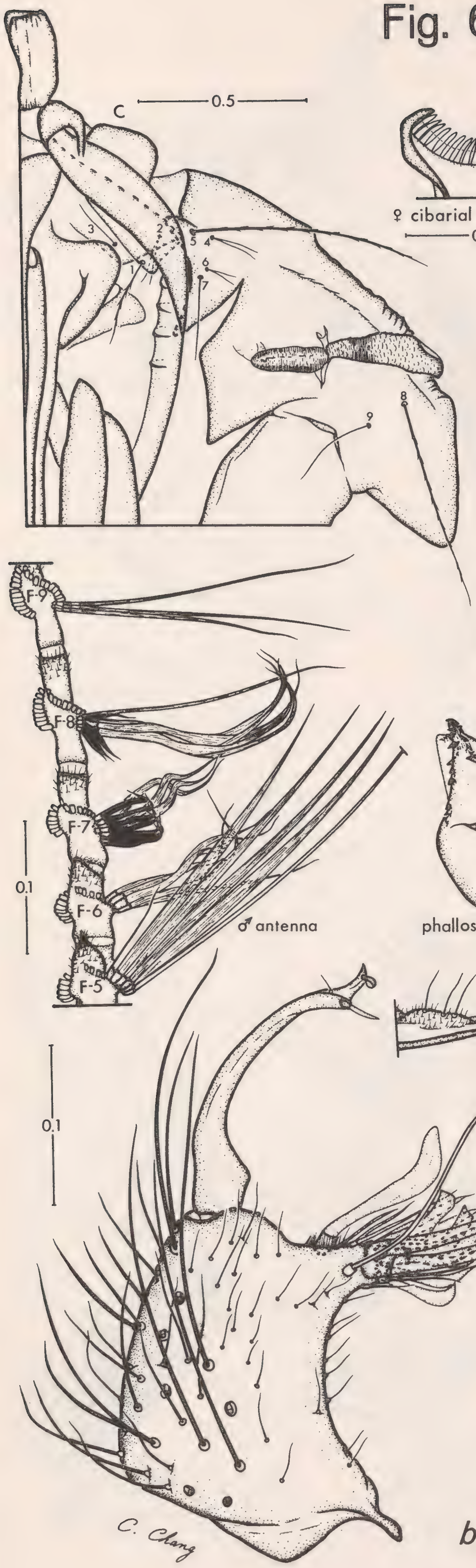
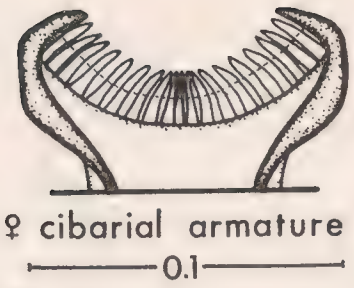
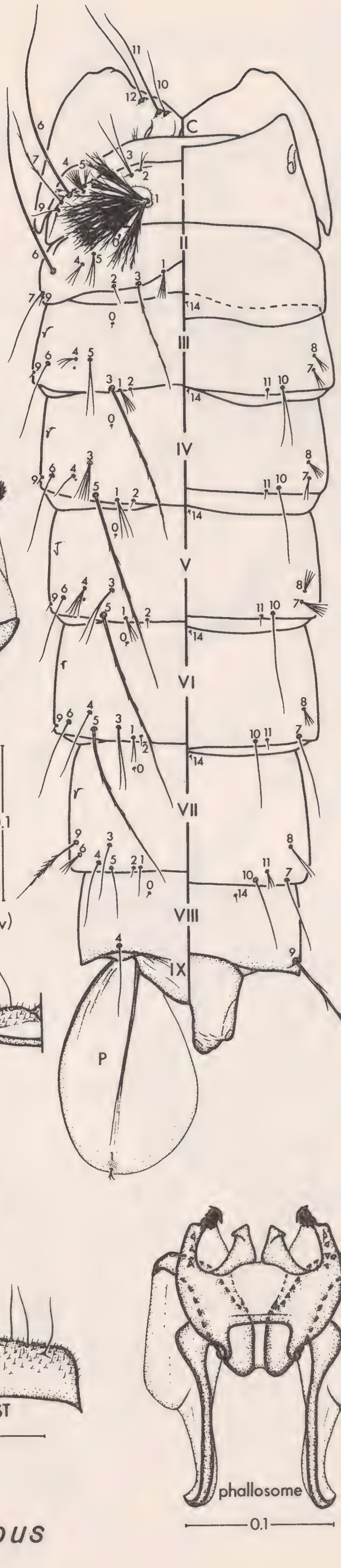

A
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jenseni
C. Chang

Fig. 65





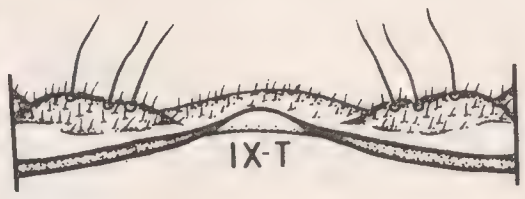




♂ antenna



phallosome (lateral view)



brevipalpus

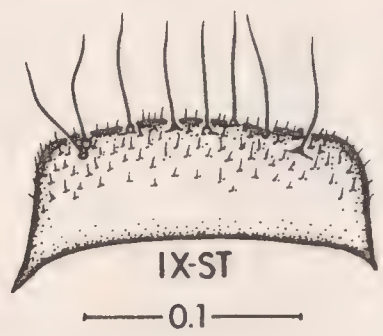
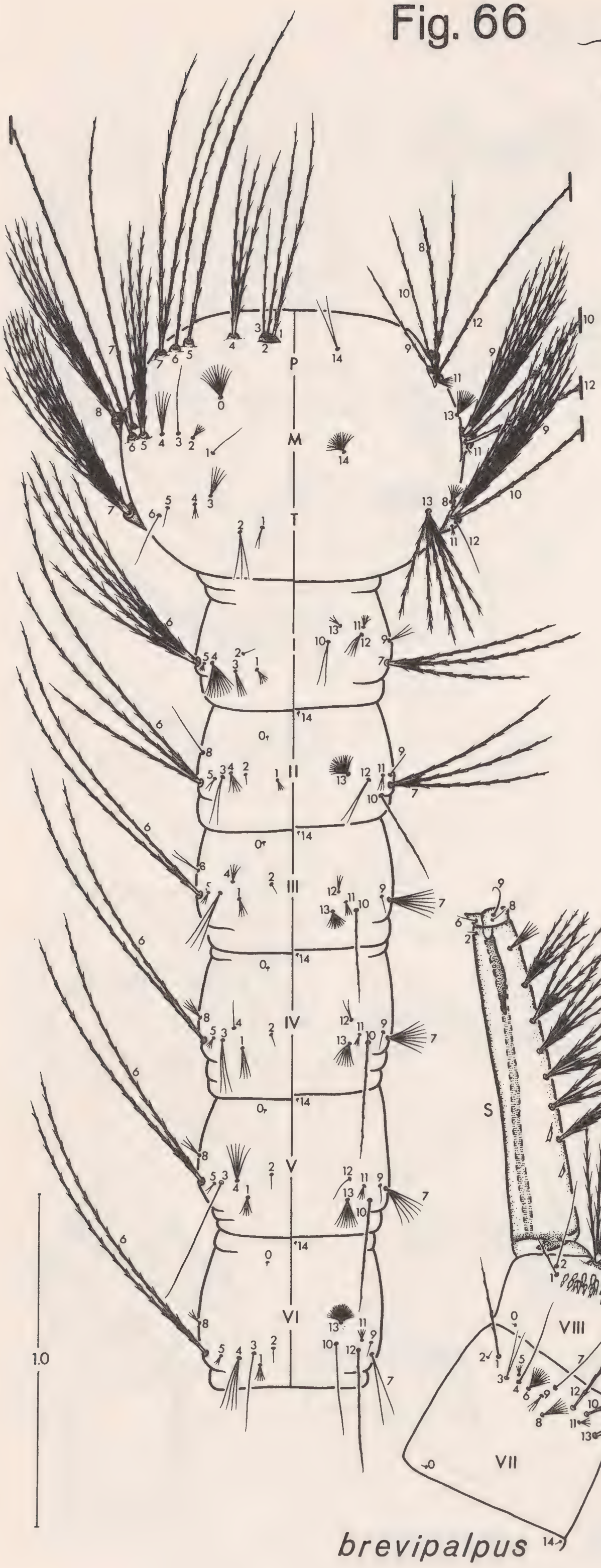
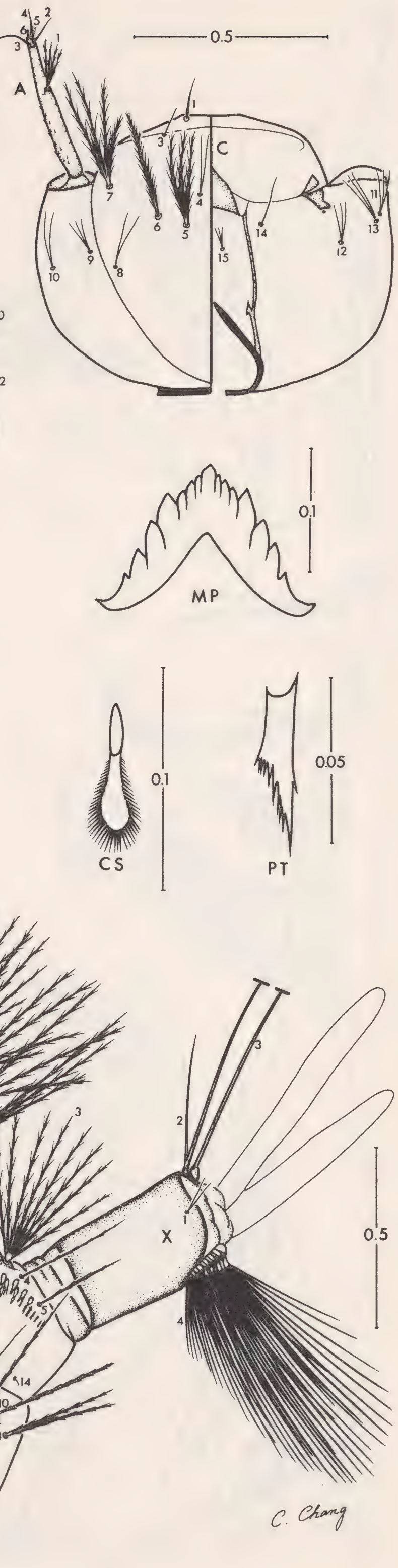


Fig. 66

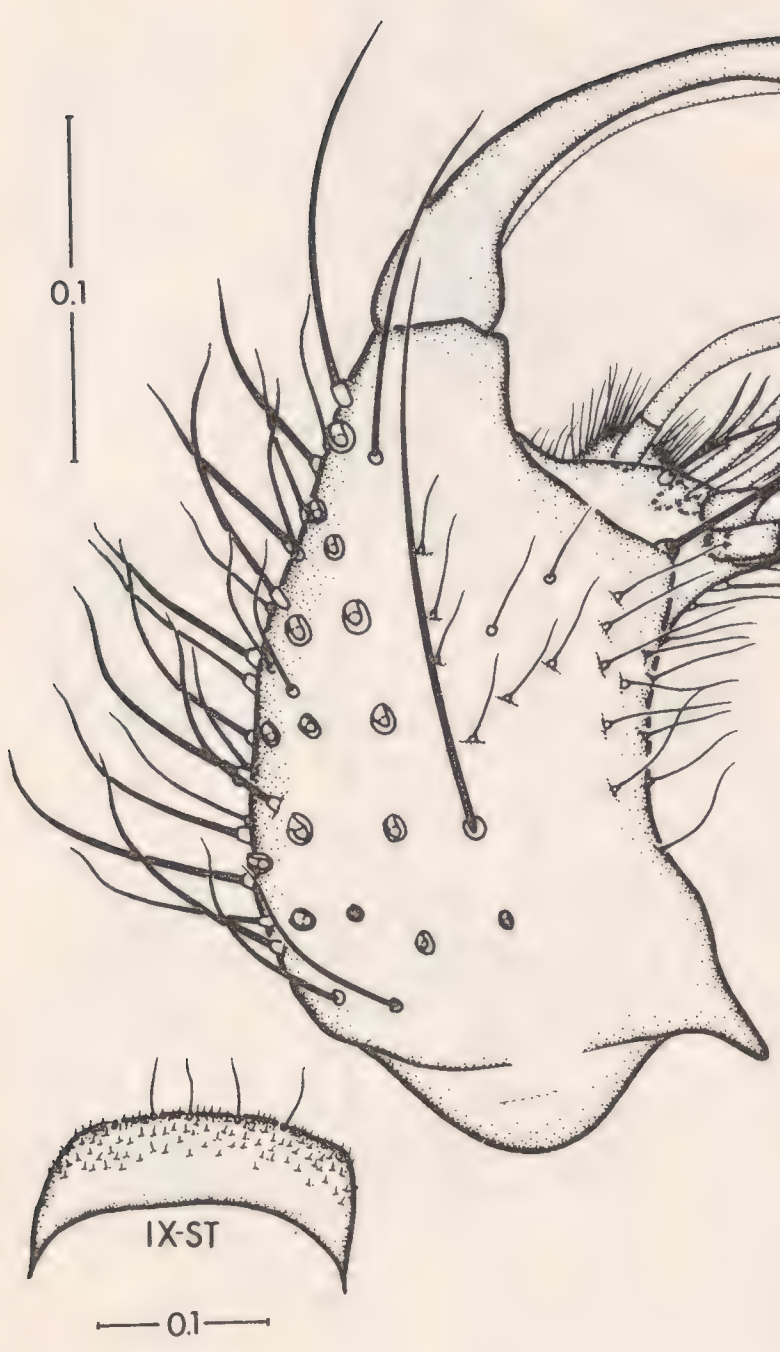


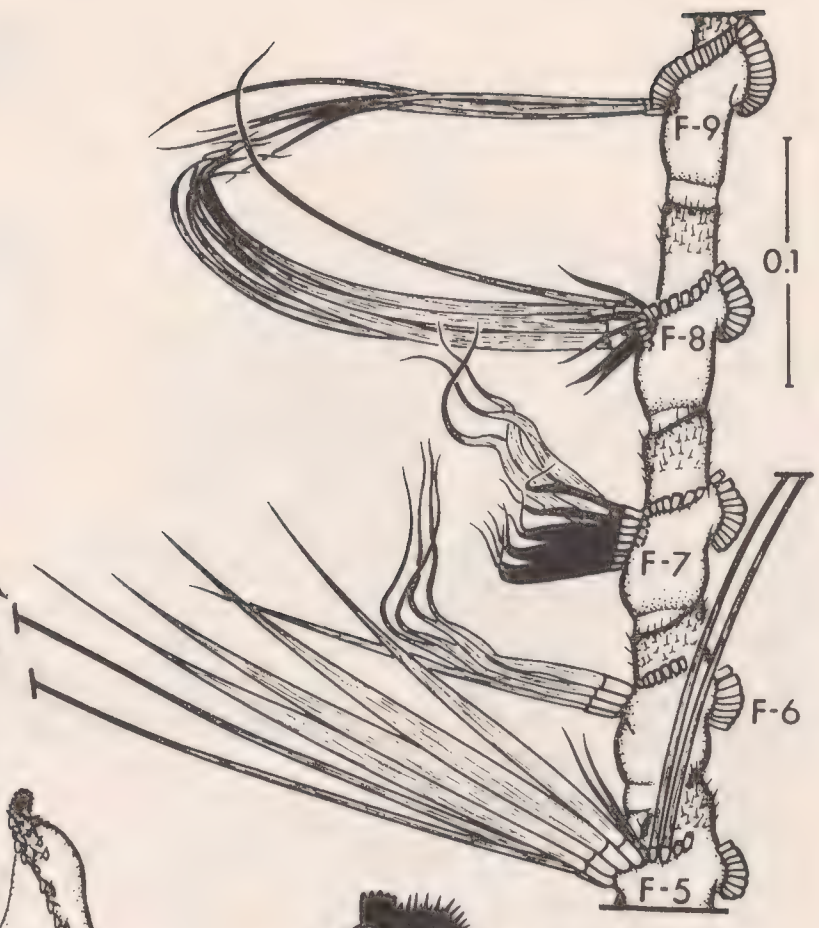


brevipalpus

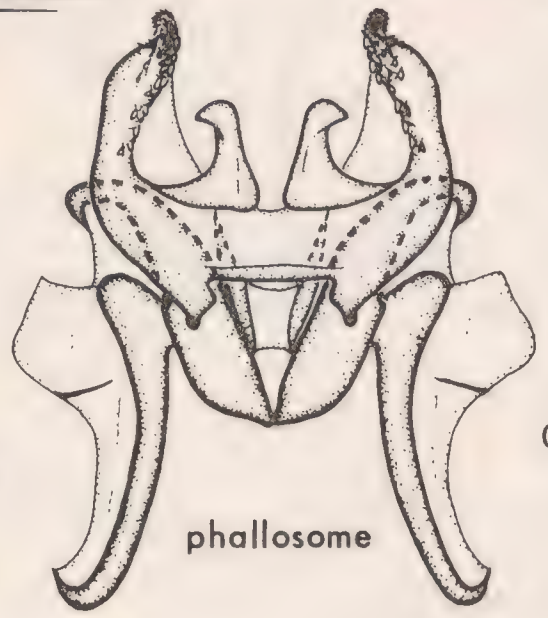
C. Chang

Fig. 67





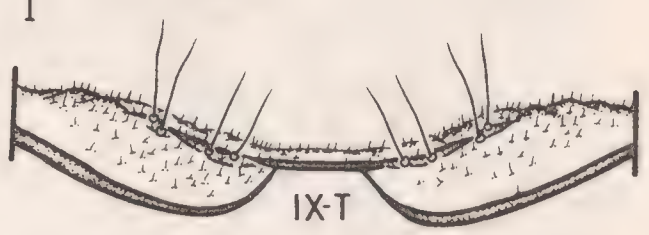
♂ antenna



phallosome

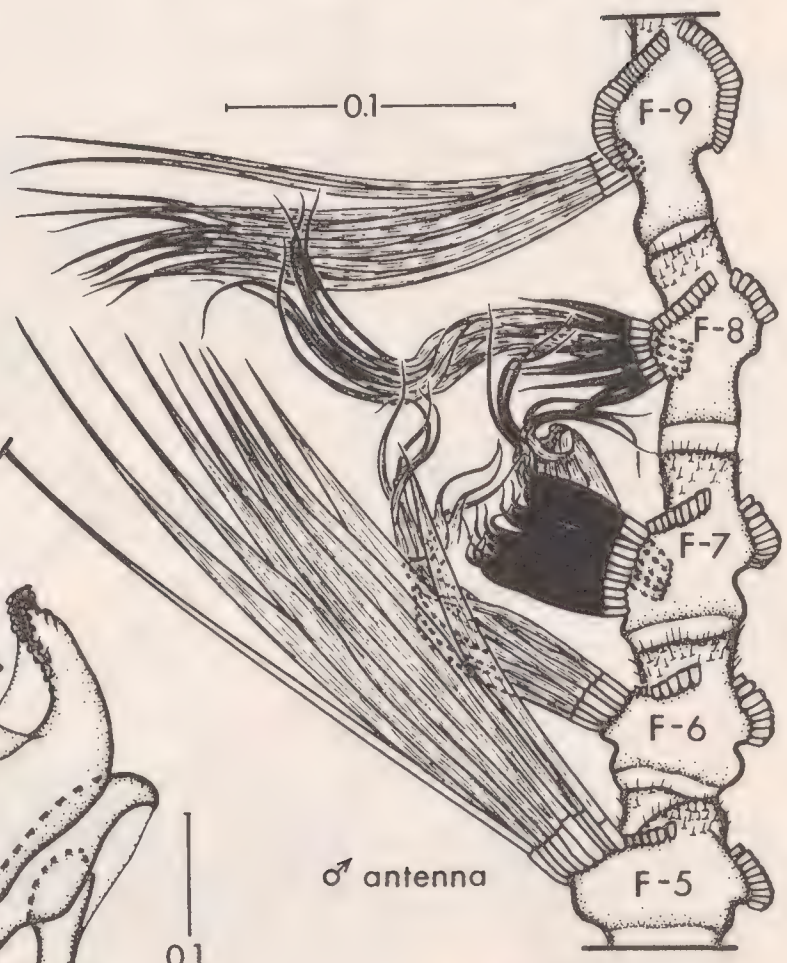


proctiger

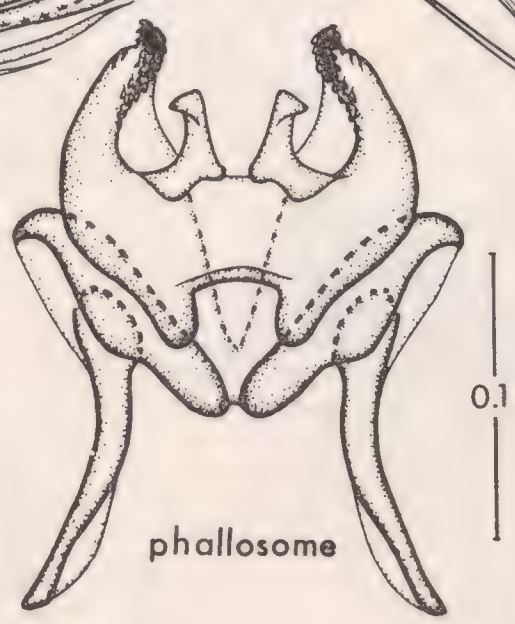


lucaris

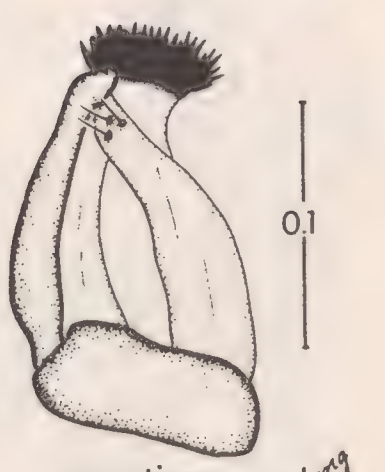




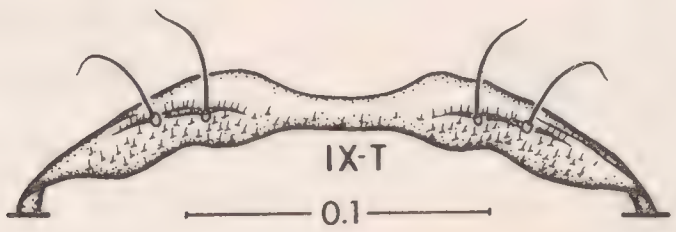
♂ antenna

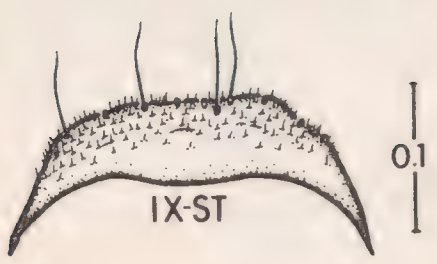


phallosome



proctiger

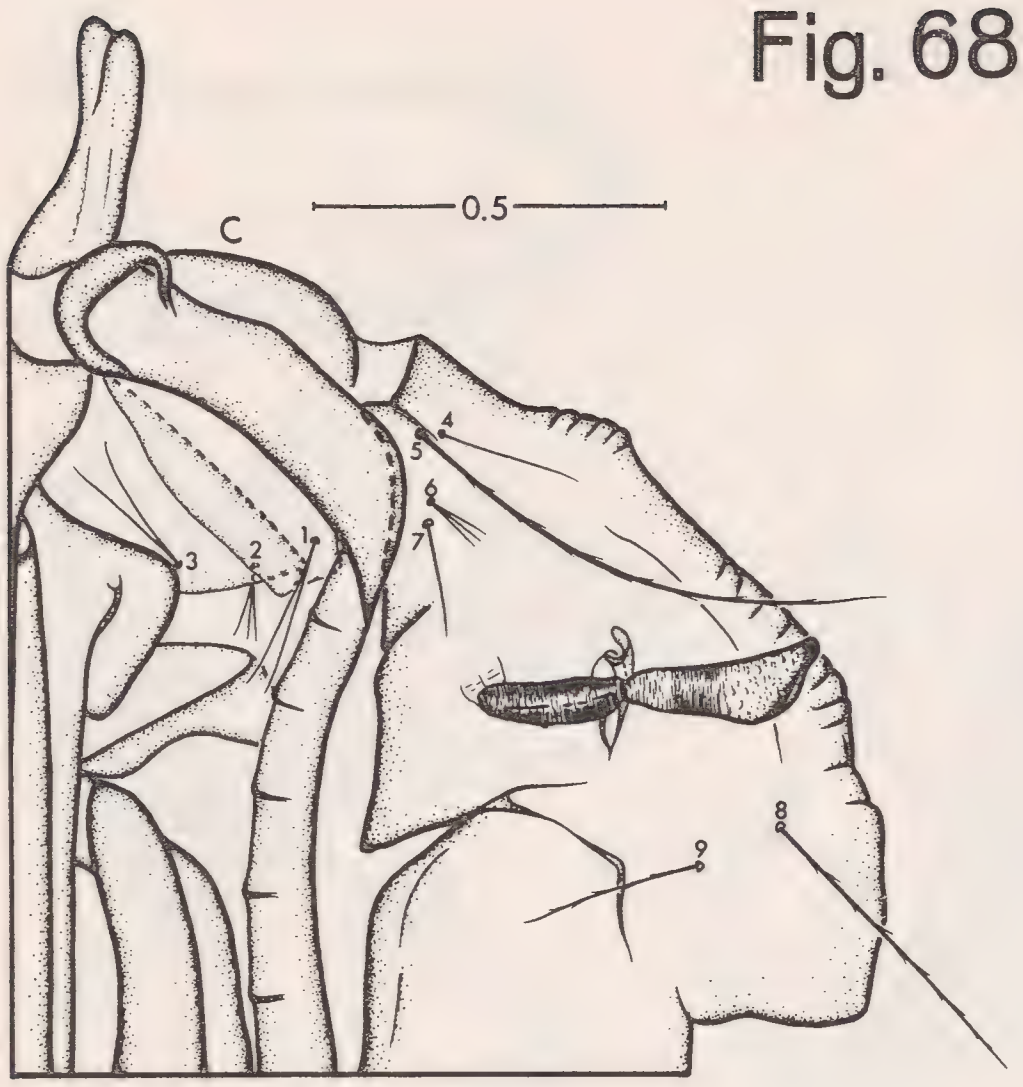


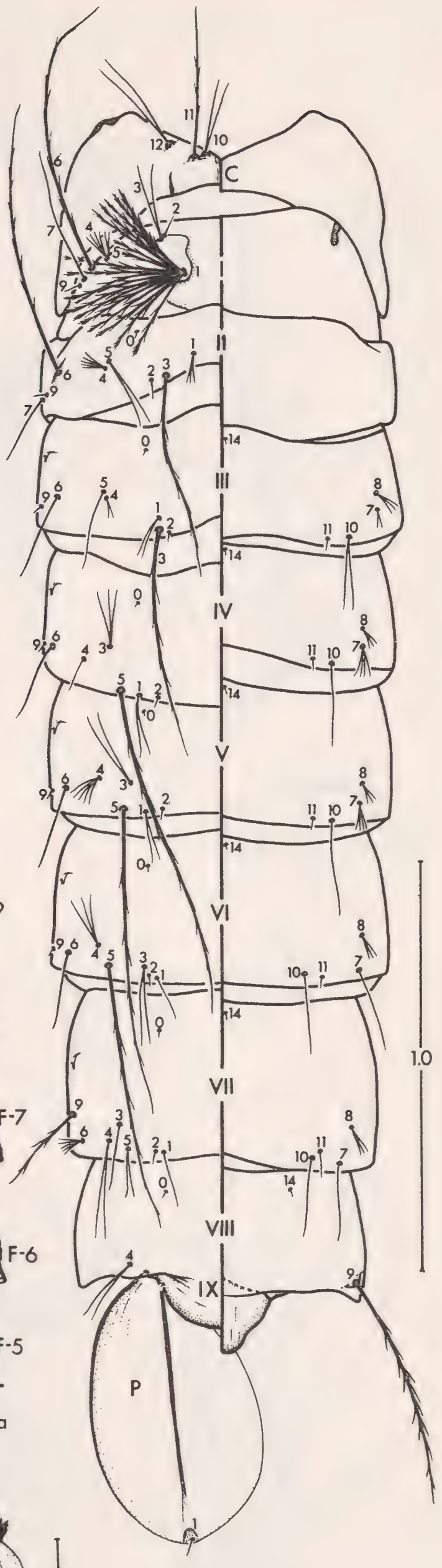


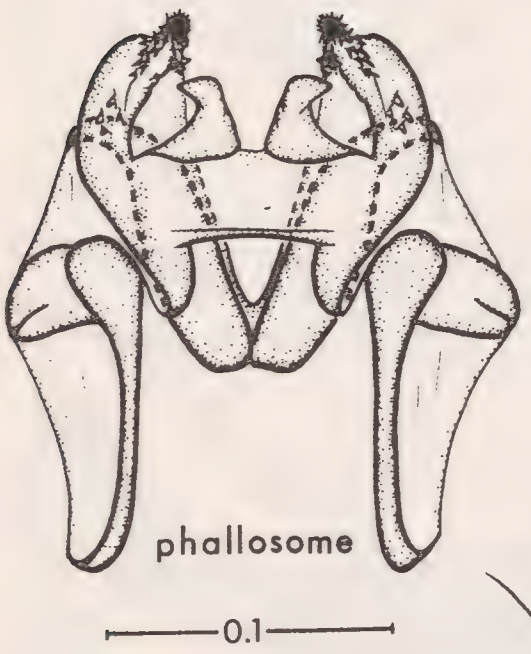
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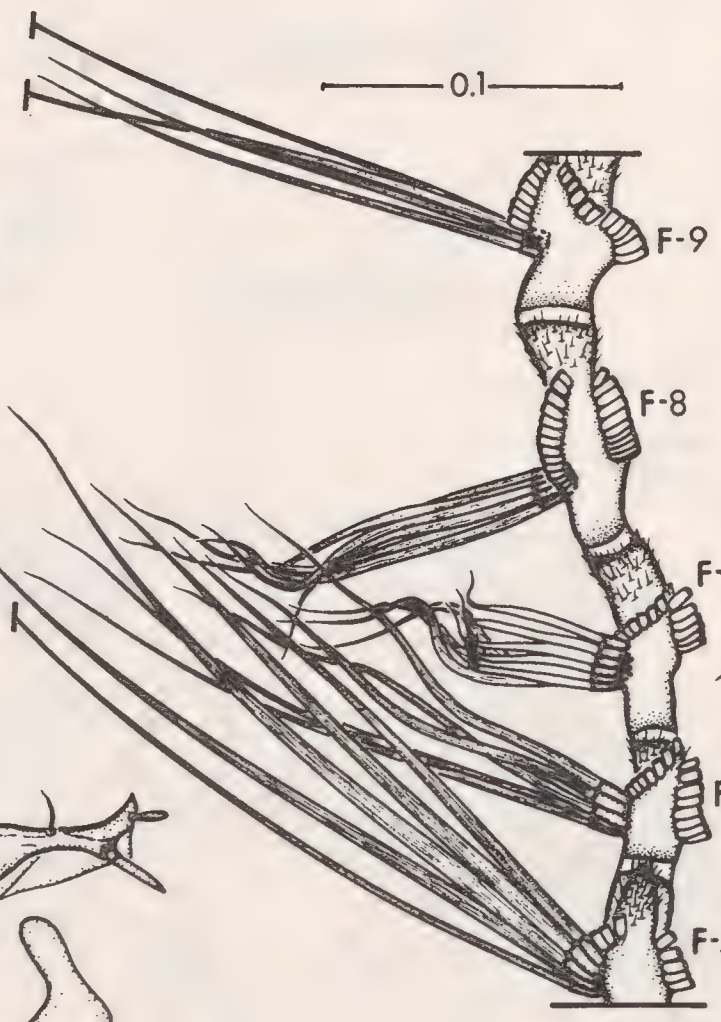
C. Chang

Fig. 68



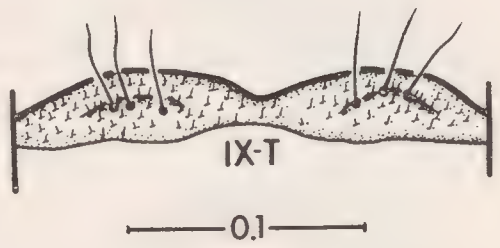






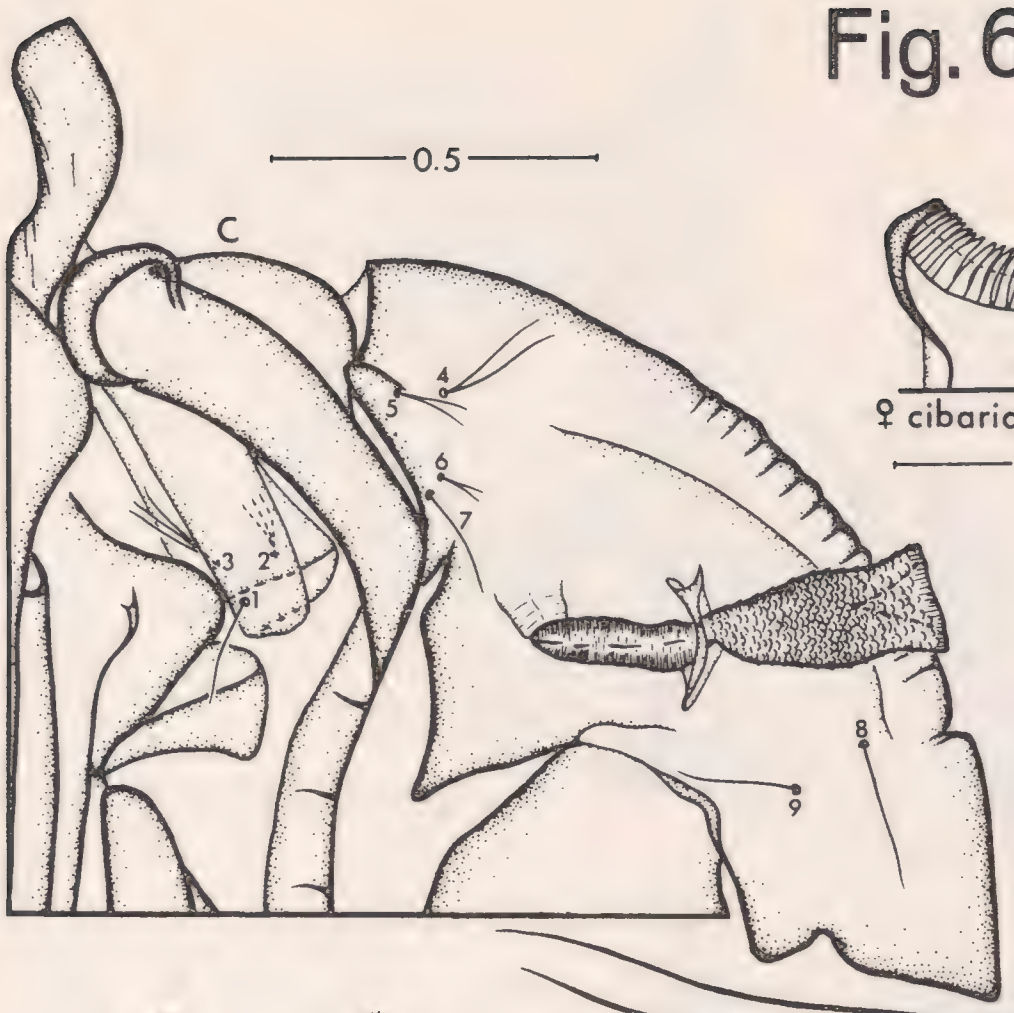


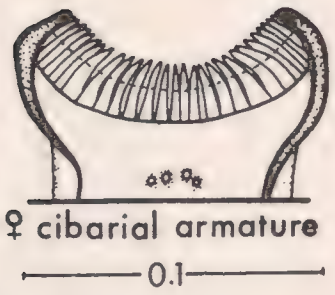


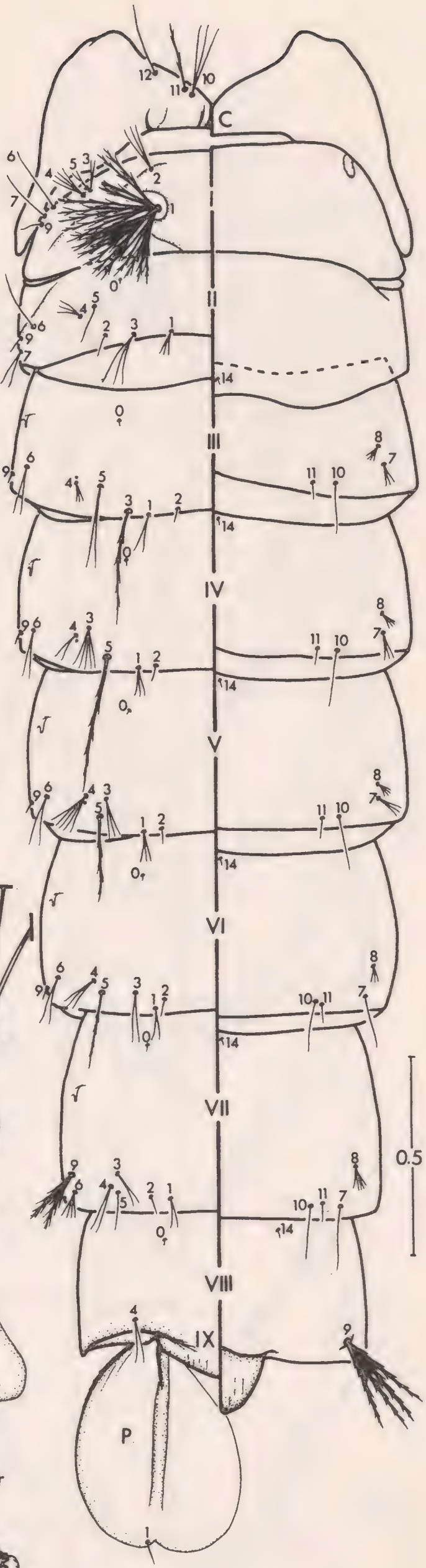


acutipalus

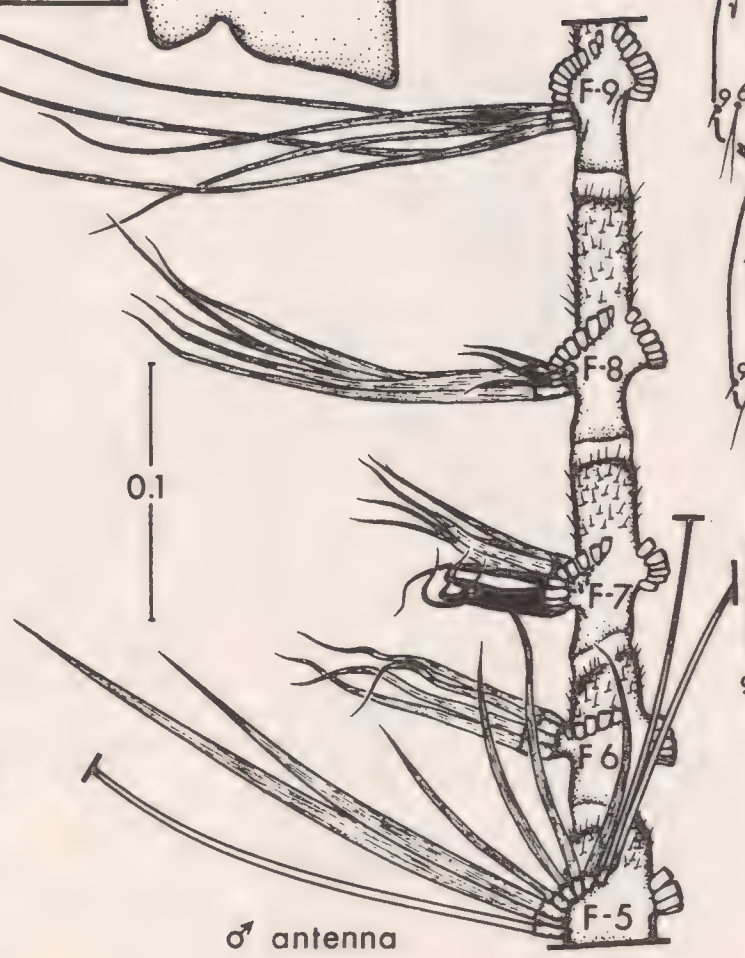
Fig. 69

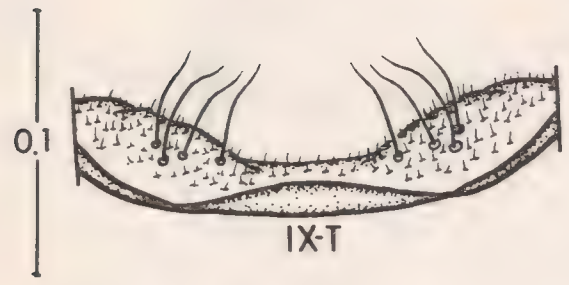




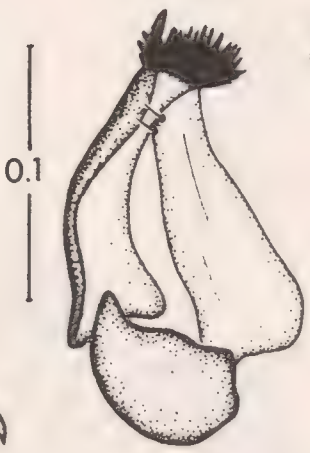






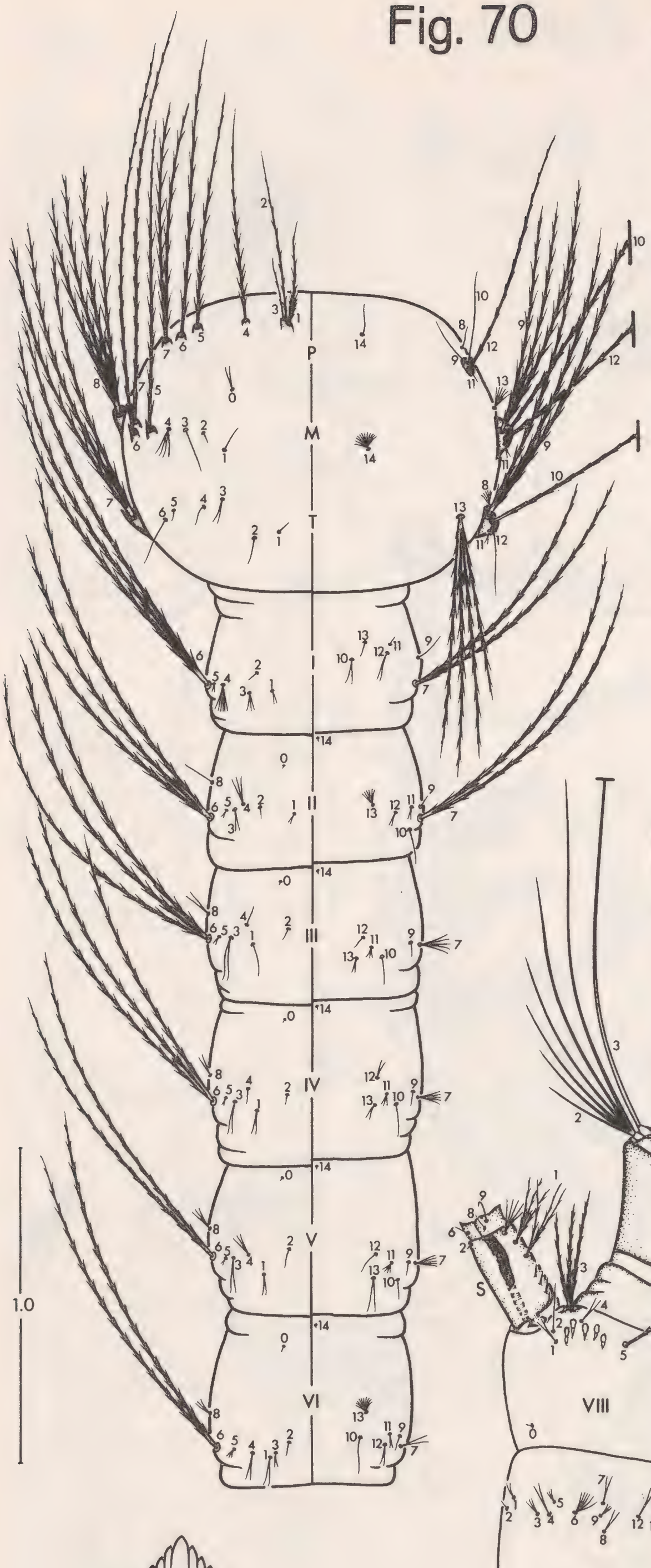


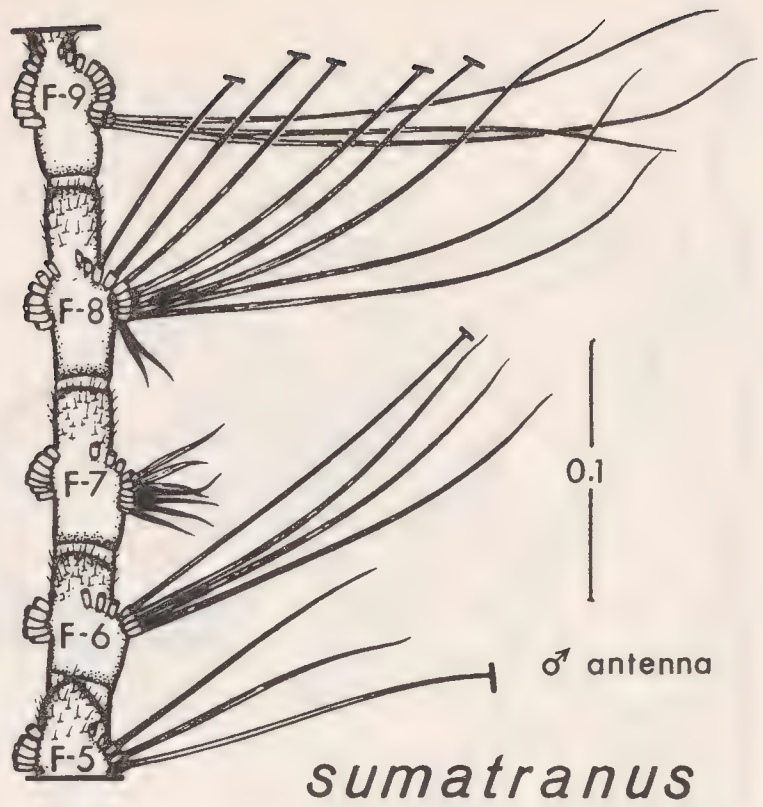




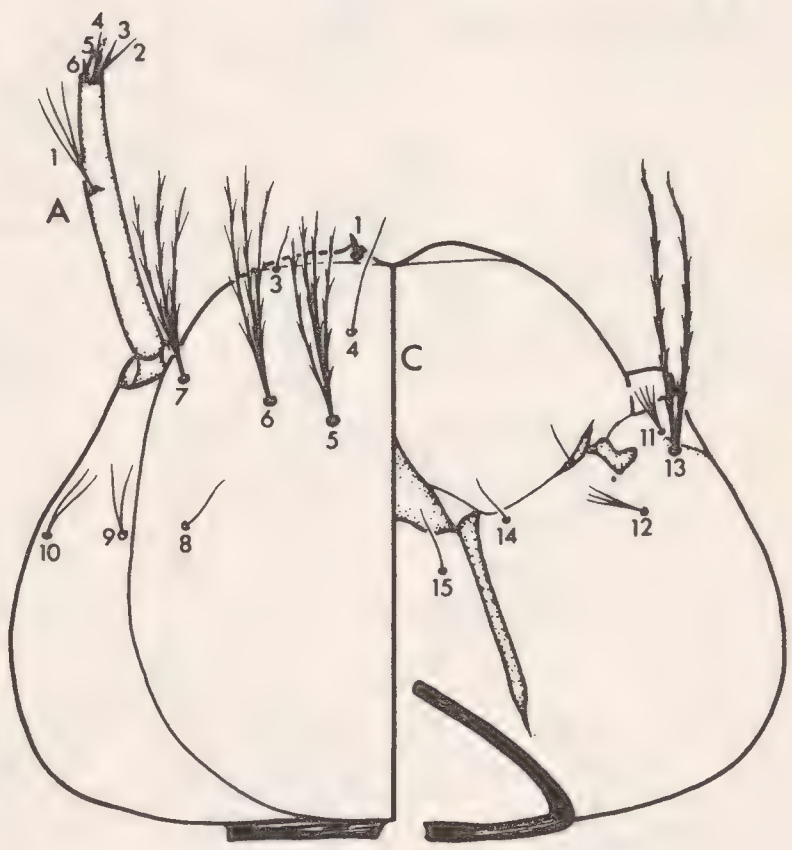
curtipalpis

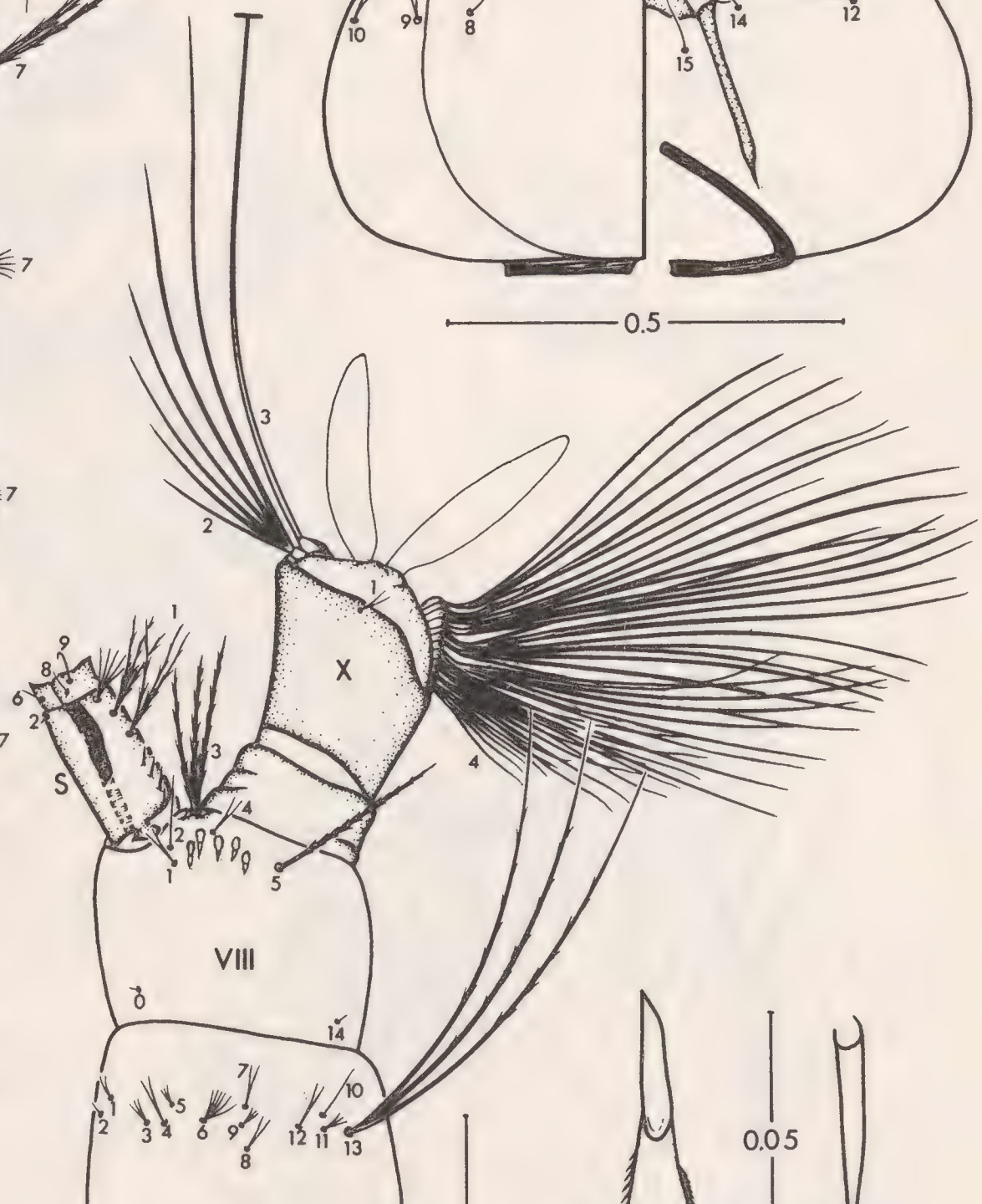
Fig. 70

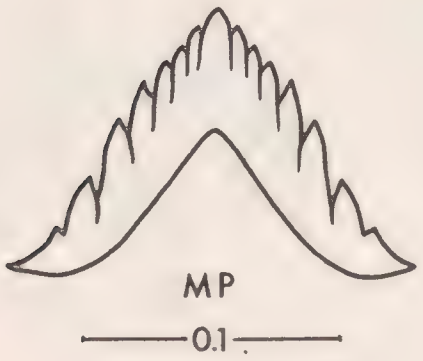




sumatranus



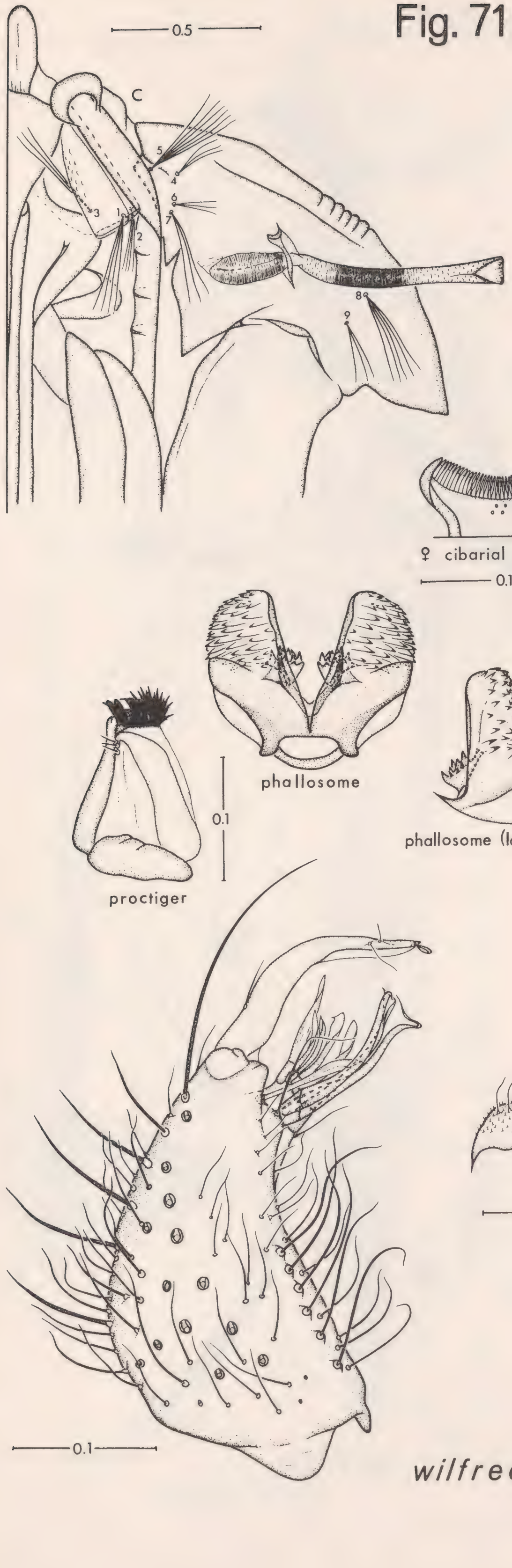




curtipalpis

C. Chang

Fig. 71



♀ cibarial armature

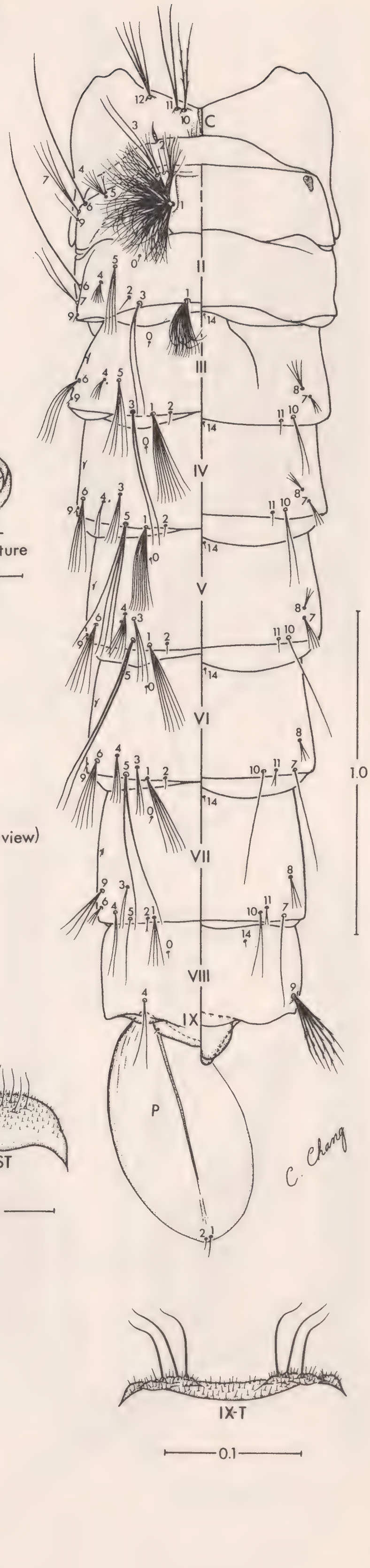
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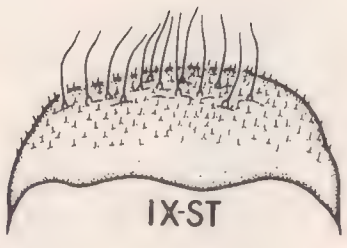
phallosome

phallosome (lateral view)

0.1

proctiger





IX-ST

0.2

0.1

wilfredi

IX-T

0.1

Fig. 72

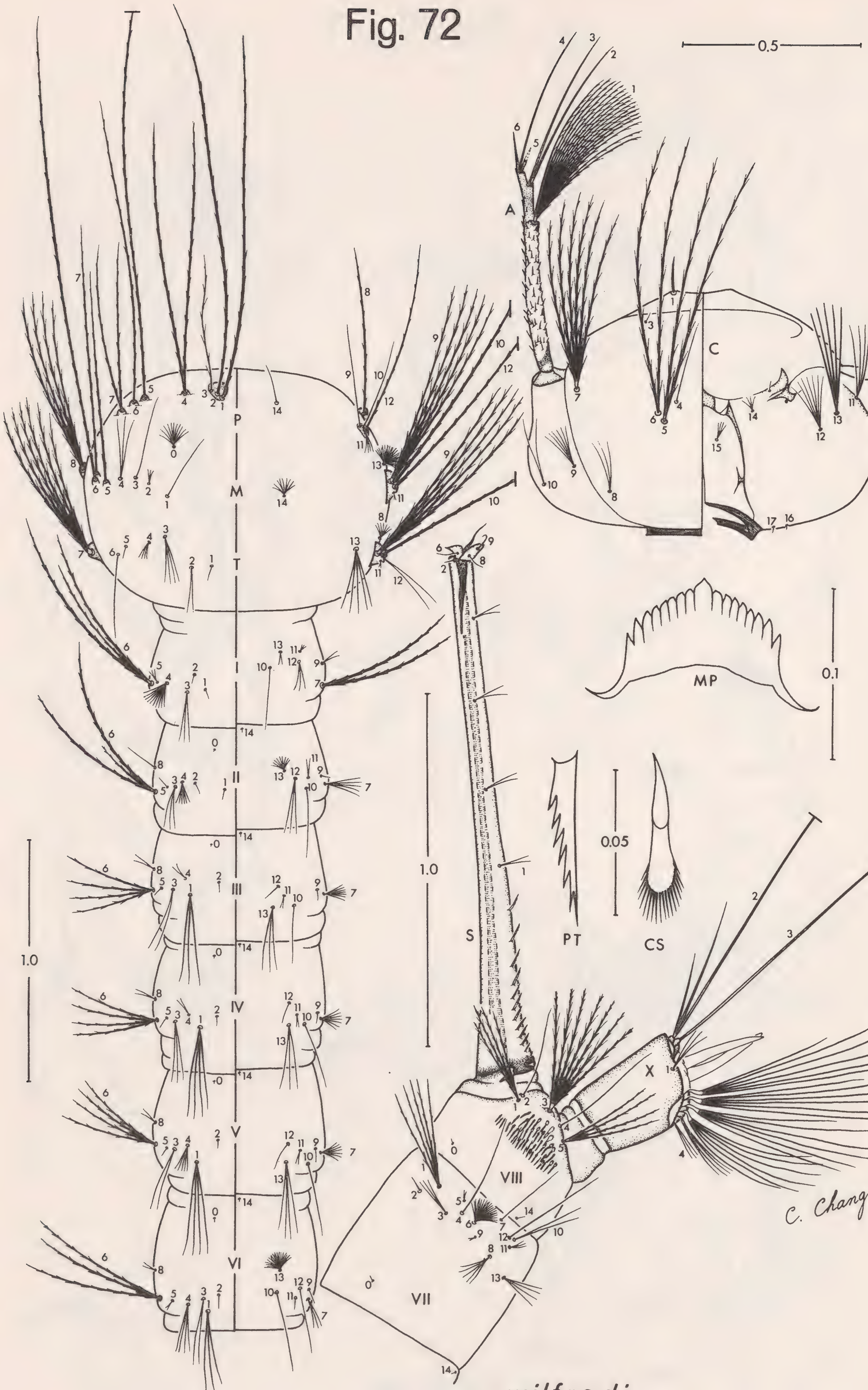
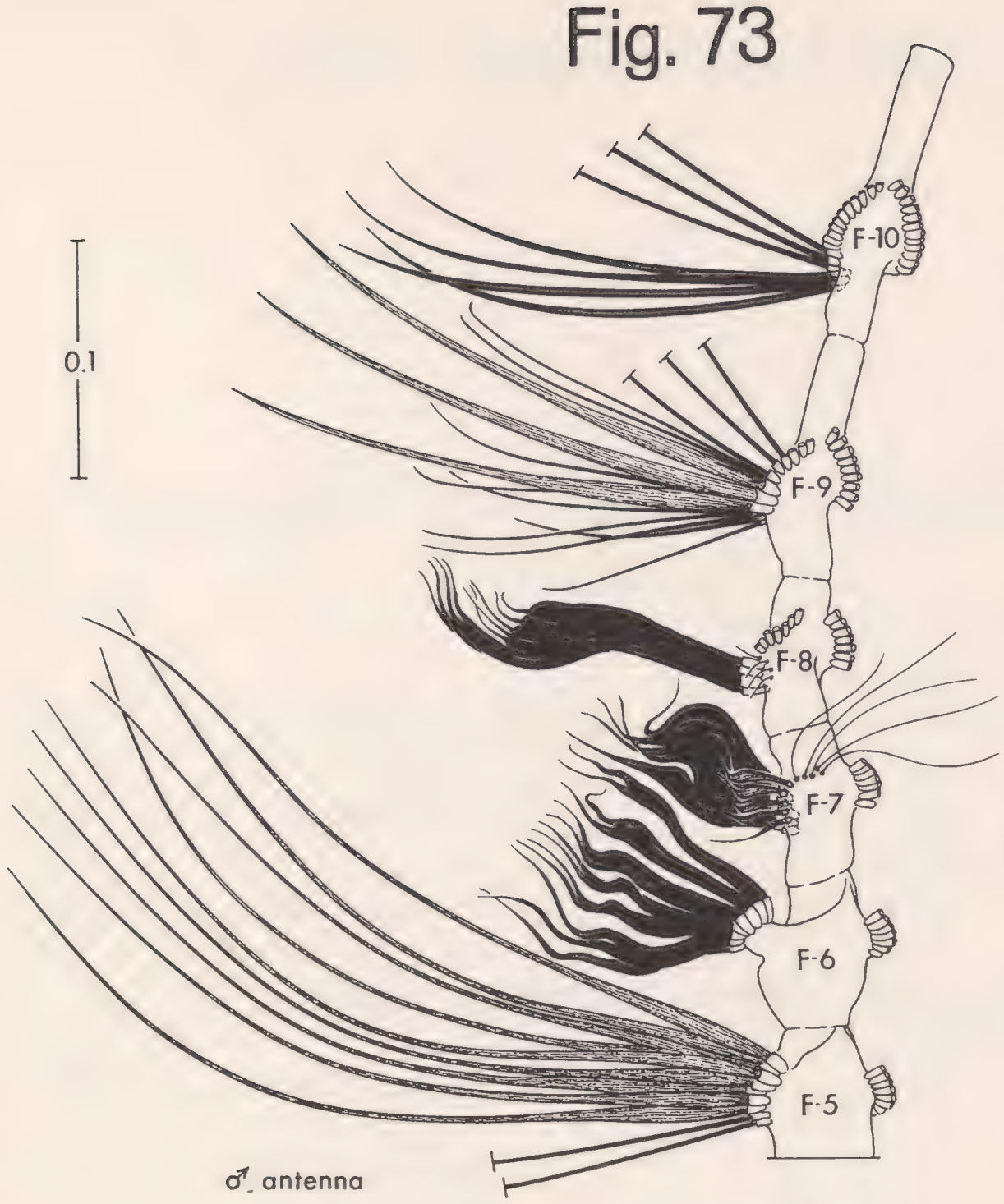
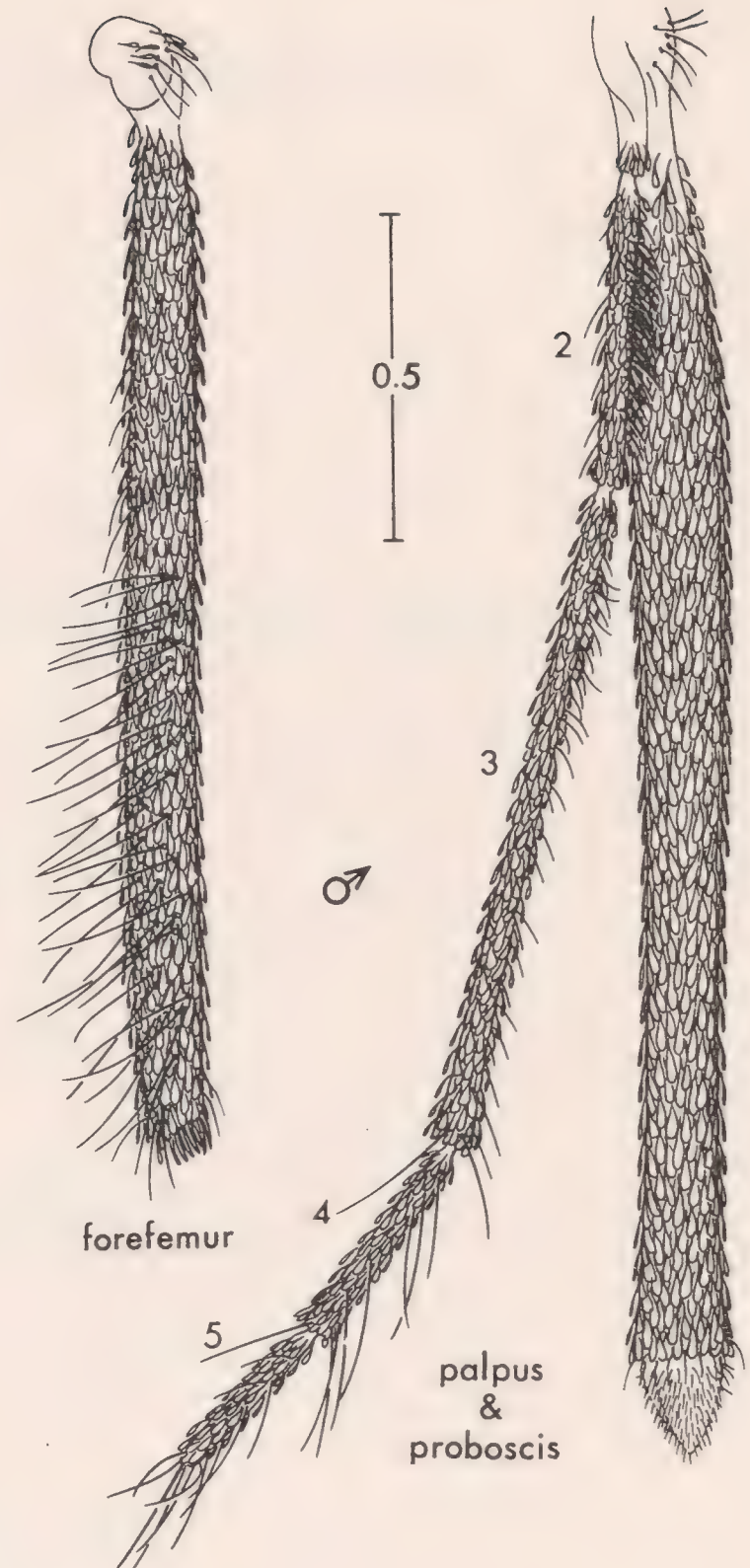

0.5
A
C
P
M
T
MP
0.1
1.0
S
PT
CS
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X
VIII
VII
VI
V
IV
III
II
C. Chang
wilfredi

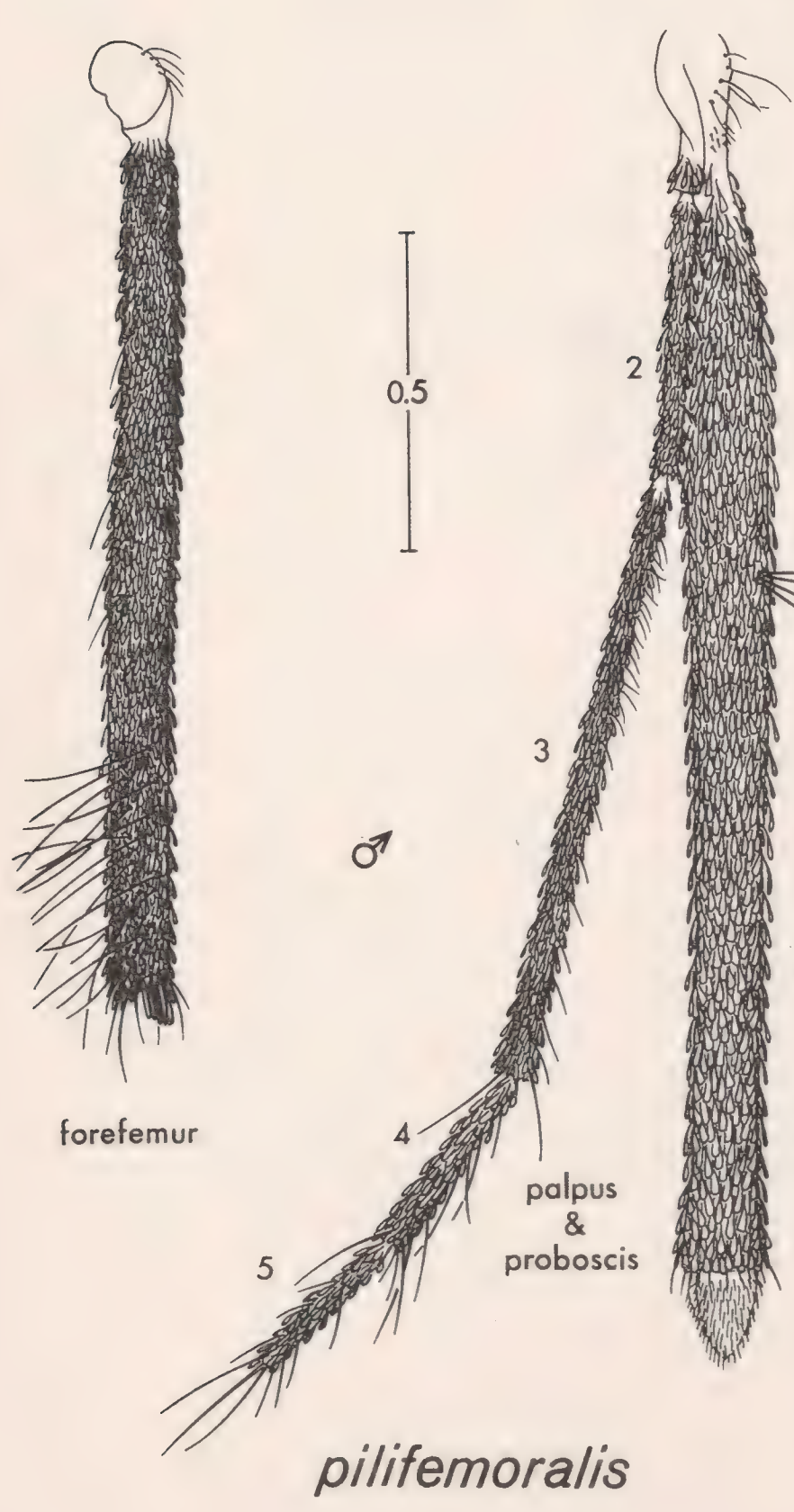
Fig. 73



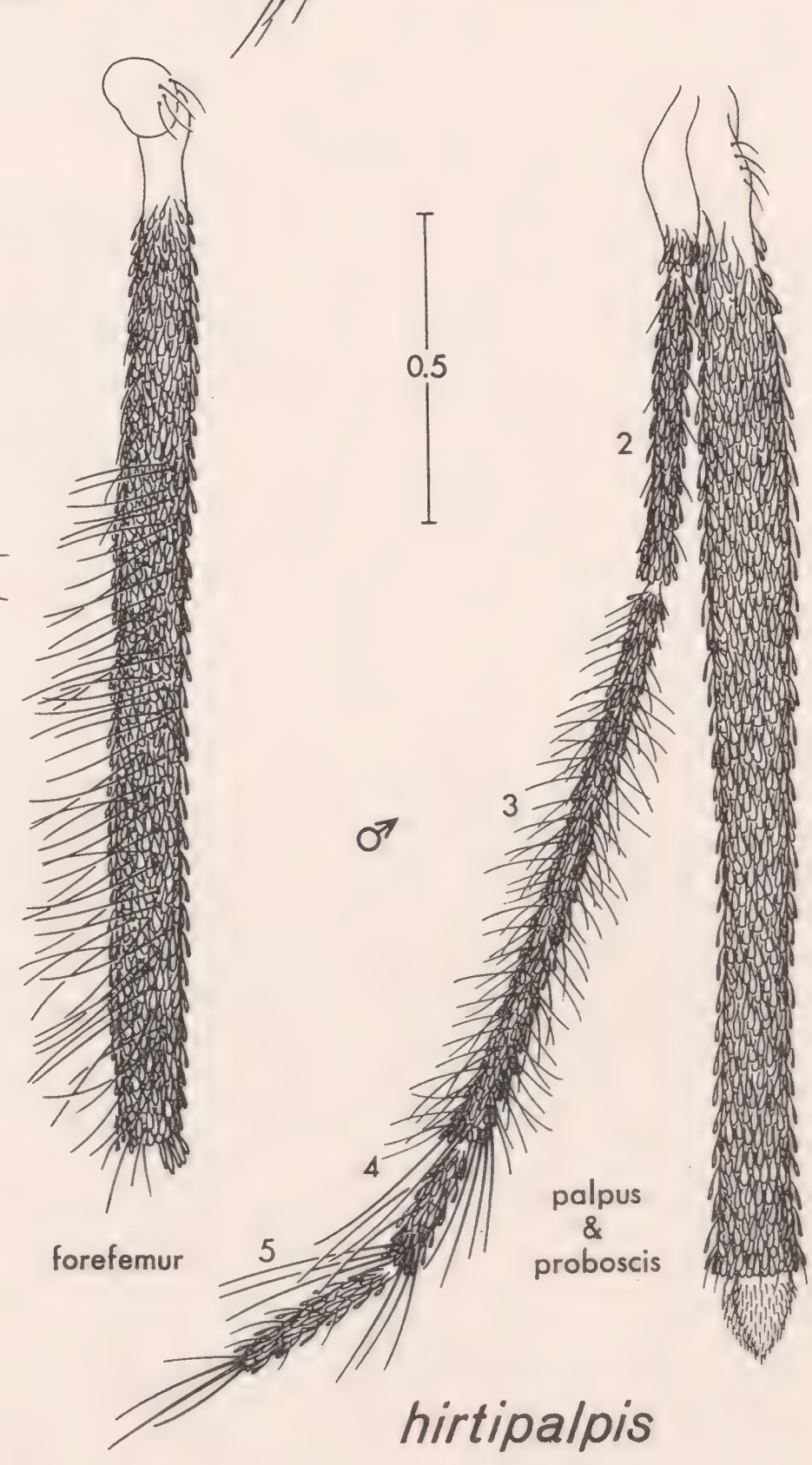
♂ antenna



wilfredi



pilifemoralis



hirtipalpis

APPENDIX A: TABLE OF DISTRIBUTION AND BREEDING HABITATS

Legend

AC - Artificial container

BB - Bamboo

CH - Crab hole

GP - Ground pools (puddle, swamp, marsh, etc.)

LA - Leaf axils

PP - Pitcher plant

RP - Rock pool

TH - Tree hole

Distribution Symbols

● - indigeneous, endemic

 - doubtful record

APPENDIX A: TABLE OF DISTRIBUTION AND BREEDING HABITATS

BREEDING HABITATS	DISTRIBUTION / SPECIES	ORIENTAL																EXTRA LIMITAL			
		India	Burma	Sri Lanka	Thailand	Cambodia	Vietnam	Penin. Malaysia	Malaysia (N. Borneo)	Singapore	Indonesia	Philippines	Taiwan	Hong Kong	S. China	Ryukyus	N. China	Japan	West Irian (Indonesia)	Papua New Guinea
	FRAUDATRIX GROUP																			
GP	*1. minutissimus*	●		●	●															
GP	*2. alorensis*										●									
GP	*3. infantulus*	●	●	●	●		●	●			★	●		●	★	●	★	●		
GP?	*4. seniori*	●																		
GP	*5. cinctellus*	●			●		●	●	●	●	●	●			★	★				
GP?	*6. fulleri*											●								
GP	*7. rubithoracis*	●	●	●	●	●	●	●		●	●	●	★	●	★			●		
GP	*8. niger*							●												
GP?	*9. gibbulus*											●								
GP	*10. inculus*					●		●												
GP, RP	*11. quadripalpis*			●	●		●	●	●	●	★	●								
GP, RP	*12. aculeatus*				●			●	●											
GP?	*13. paraculeatus*								●			●								
GP?	*14. aestivus*								●											
GP	*15. reidi*				●			●	●	●		●								
GP	*16. variatus*	★			●		●	●	●	●	★				★					
GP?	*17. josephinae*											●								
GP	*18. cubitatus*							●	●	●	●	●							●	●
GP	*19. gracicornis*				●			●												
GP	*20. whartoni*				●			●	●	●	●									
GP	*21. macdonaldi*	●			●		●	●	●	●	●	●								
GP	*22. pairoji*				●			●	●	●										
GP	*23. alphus*				●			●	●	●										
	MAMMILIFER GROUP																			
TH	*24. impostor*								●											
TH, BB,	*25. traubi*				●			●	●		●									
TH, BB, RP,	*26. uniformis*	●		●																
TH, AC	*27. lavatae*								●			●								
GP, RP, BB, LA	*28. mammilifer*	●		●	●			●	●		●	●			●					
GP, RP	*29. wardi*			●																

APPENDIX A: TABLE OF DISTRIBUTION AND BREEDING HABITATS (Continued)

BREEDING HABITATS	SPECIES / DISTRIBUTION	ORIENTAL															EXTRA LIMITAL			
		India	Burma	Sri Lanka	Thailand	Cambodia	Vietnam	Penin. Malaysia	Malaysia (N. Borneo)	Singapore	Indonesia	Philippines	Taiwan	Hong Kong	S. China	Ryukyus	N. China	Japan	West Irian (Indonesia)	Papua New Guinea
TH	*30. demissus*				●			●												
TH, BB, LA, AC,	*31. ganapathi*				●			●	★											
BB, TH,	*32. spiculosus*		●		●			●					●							
TH, BB, RP	*33. minor*	●	●		●			●	●		●	●							●	
RP, TH, BB, GP, AC, LA	*34. bicornutus*	●	●	●	●		●	●					★			●				
TH, BB, RP	*35. bandoengensis*							●			●			●						
RP, TH, BB, GP, AC, LA	*36. tuberis*				●											●				
TH, BB, RP	*37. kuhnsi*								●			●							●	●
RP	*38. crassicomus*							●	●											
TH, BB, RP, AC	*39. incomptus*				●															
GP, RP, TH	*40. bengalensis*	●			●		●	●							★					
TH, BB, AC, RP	*41. peytoni*	●			●		●	●			●									
RP, TH, BB, CH, AC, GP	*42. eukrines*				●															
CH, GP	*43. pholeter*				●															
RP	*44. flavicornis*	●																		
GP	*45. lasiopalpis*			●																
PP	*46. navalis*							●	●	●										
PP	*47. coerulescens*							●	●	●										
PP	*48. hewitti*							●	●	●										
PP	*49. jenseni*								●	●	●									
PP	*50. brevipalpus*							●	●	●										
PP	*51. lucaris*				●			●		●										
PP	*52. eminentia*							●	●	●										
PP	*53. acutipalus*							●		●										
PP	*54. curtipalpis*				●			●	●	●	●									
PP	*55. sumatranus*					●	●				●			●						
	WILFREDI GROUP																			
GP	*56. wilfredi*				●		●	●												
GP	*57. pilifemoralis*				●										●					
GP?	*58. hirtipalpis*				●															

APPENDIX B: CURRENT TAXONOMIC CHANGES

NEW TAXA

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alorensis 25
gracicornis 58
hirtipalpis 152
impostor 80
lasiopalpis 123
pairoji 63
paraculeatus 49
wardi 90

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bernardi, to nomen dubium 9
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fuscosiphonis, synonymy 91
hui, synonymy 96
mindanaoensis, to nomen dubium 9
pachecoi, synonymy 44
plantaginis, synonymy 98
uniformis, subsp. *mercedesae*, synonymy 107

LECTOTYPE SELECTION

hewitti 132
navalis 128
pachecoi 46
plantaginis 100
uniformis 85

INDEX

Names of valid taxa are set in roman type, synonyms and invalid names are italicized. Italicized numerals refer to the principal text references, roman numerals to secondary text reference, with suffix k indicating diagnosis given in a key. Numerals enclosed in parentheses refer to figures.

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